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THE STATUS OF THE NATION'S HIGHWAYS: CONDITIONS AND PERFORMANCE

REPORT

OF THE

SECRETARY OF TRANSPORTATION

TO THE

UNITED STATES CONGRESS

Pursuant to Section 307 of Title 23, United States Code

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THE SECRETARY OF TRANSPORTATION
WASHINGTON, D.C. 20590

MAY 24 1985

The Honorable Thomas P. O'Neill, Jr.
Speaker of the House of Representatives
Washington, D.C. 20515

Dear Mr. Speaker:

The enclosed report, "The Status of the Nation's Highways: Conditions and Performance," is submitted in response to Section 307 of Title 23, United States Code. This is the eighth in a biennial series of reports to Congress on the Nation's highway needs.

The report assesses the quality of highway service as reflected by objective conditions and performance measures and describes changes in those measures in recent years. In addition, the report estimates future capital spending, irrespective of governmental jurisdiction, required to achieve various levels of future highway service.

Sincerely,

Jim Burnley

Jim Burnley
Acting Secretary

Enclosure

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CHAPTER I

STATUS OF THE NATION'S HIGHWAYS: CONDITIONS AND PERFORMANCE

1985

INTRODUCTION AND SUMMARY

This is the eighth in a series of biennial reports submitted to Congress pursuant to Section 3 of P.L. 89-139 (amended by Section 160 of P.L. 97-424) (23 U.S.C. 307) which requires estimates of the future highway needs of the Nation.

The purpose of this report is to describe selected aspects of the system including finance, physical and operating characteristics, and future highway needs. In addition, these data are compared with similar information from two prior reports, 1981 and 1983, to provide a time series of trends on finance, conditions, and needs. The final chapter is devoted to an examination of the social, economic, and demographic factors that contribute to highway demand, with particular emphasis on geographic shifts that have influenced demand in the recent past and can be expected to continue this influence through the end of the century.

Report Approach and Usage

This report and other supporting program-specific documents are useful in developing and analyzing program and policy options, and in evaluating the effects of current policies and programs on system performance. In addition, the information in this report is used extensively by highway interest groups, other modes, private industry, and the media for a variety of purposes including policy debate, market analysis, and news reporting.

The analytical methodologies used in this report have been made available in appropriately modified form to the State transportation agencies for their use in assessing conditions and needs within a given State. The methodologies have remained intact, but have undergone extensive refinement with the publication of each of the last three reports. Consequently, the report has taken on a time-series mantle as opposed to a "snapshot" perspective. Trends can be identified, comparisons drawn, forecasts examined, and policies monitored more effectively than in the past. Significant trends are noted and changes in methodology are described throughout the report.

Recent Program Highlights

The increase in user fees brought about by Title V of the Surface Transportation Assistance Act (STAA) of 1982 marked the most significant change in the Federal role in highway finance since the 1956 Act established the Highway Trust Fund. The debate preceding (and following) passage of the STAA centered on the effects of increased Federal user fees on highway users and State and Federal programs and the speed with which the fee increase could be translated into highway improvements. This report describes and measures, where possible at this early date, the effects of that legislation on Federal and State highway expenditure patterns and resulting changes in condition. Normally, only 16-17 percent of Federal-aid obligations are disbursed in the year in which they are obligated. Finance and condition data require approximately one year to collect and report. This report follows the most recent report by only 2 years. Therefore, it is too early to expect measurable changes to be observed by the end of 1983, the latest condition data reported here.

As Chapter II describes, however, for the years 1984 and 1985, the years to be included in the next biennial report, significant advances in highway financing are being made and will become evident. There are indications in Chapter III, as well, that highway agencies are arresting the downward trends in pavement conditions and are actually reversing the trend in some areas.

Scope

The report covers two time periods. The first is the period 1980-1983 and includes information about finances, conditions and usage compiled in those years. The second is the period from 1983 through the year 2000. The report views highway issues primarily from a national, or aggregate perspective, although data contained in certain sections illustrate that there is a wide variance in conditions among individual States. The report concentrates on the performance and condition of the Nation's arterial and collector systems. This is not because local roads are without problems, but because the Federal role, as delineated by Congress, has focused on arterial and collector facilities. Local road needs are not included in this report, although some finance information is provided in Chapter II.

Finally, the nature of the data collected for this report limits the level of detail to the more prominent Federal categorical programs, such as the Interstate, primary, secondary, urban, and bridge. Federal-aid program discussions contained in Chapter V, therefore, focus on these five major categories which account for over 90 percent of the Federal-aid highway funds from the highway account of the Trust Fund.

Highway Systems

Throughout this report references are made to functional and Federal-aid systems. All roads are classified functionally. A subset of all roads are designated as Federal-aid systems, eligible for Federal funding. The various systems are defined as follow:

Federal-Aid Systems

- The National System of Interstate and Defense Highways - consists of routes of highest importance to the Nation that connect, as directly as possible, the principal metropolitan areas, cities, and industrial centers, including important routes into, through, and around urban areas; serve the national defense and, to the greatest extent possible, connect at suitable border points with routes of continental importance in Canada and Mexico. The Interstate System is a subsystem of the primary system.
- The Federal-Aid Primary System - consists of a system of interconnected main roads important to interstate, statewide, and regional travel, consisting of rural arterial routes and their extensions into or through urban areas.
- The Federal-Aid Secondary System - consists of rural major collector routes.
- The Federal-Aid Urban System - consists of urban arterial and collector routes exclusive of urban extensions of the Federal-aid primary system.

Functional Systems

- Principal Arterial System - In rural areas, a network of routes that primarily serve travel of statewide or interstate significance; that serve virtually all urban areas over 50,000 population; that provide high overall travel speeds with minimum interference to through activity; that serve the highest traffic volume corridors and the longest trip lengths; and that carry a high proportion of urban area travel.

  The principal arterial system is stratified as follows: (a) Interstate, (b) other freeways and expressways (in urban areas only), and (c) other principal arterials.

- Minor Arterial System - In rural areas, a network of routes that provide access to principal arterial routes and, in conjunction with principal arterials, that link cities and larger towns to facilitate interstate and intercounty service.

  In urban areas, this system serves trips of moderate length at a somewhat lower level of travel mobility. Such routes interconnect with and augment the principal arterial system. They may carry local bus routes and provide intracommunity connectivity.

- Collector System - In rural areas, a network of routes that generally serve travel of a localized nature and on which predominant travel distances are shorter than on arterial routes. The rural collector system is stratified as follows: (a) major collectors - serving county seats and other traffic generators not directly served by arterial routes, and (b) minor collectors - linking locally important traffic generators with smaller communities.

  In urban areas, such routes distribute trips to and from the arterials. Such routes provide for local traffic movement within residential neighborhoods, commercial areas, and industrial areas.

Information Sources

The Federal Highway Administration (FHWA) and the States have jointly developed and implemented the Highway Performance Monitoring System (HPMS), a data system which supplies timely information about the condition and use of the major highway systems and about the capital investments being made to improve these highways. The HPMS is the primary source of information contained in this report. It supplies those involved in highway program development and management a continuous picture of how and where conditions are changing and how investment levels and patterns relate to the changes.

HIGHWAY FINANCE TRENDS

Highway financing is a highly complex system that includes extensive use of revenue transfers involving thousands of individual jurisdictions. Federal, State, and local governments use a variety of revenue raising mechanisms to finance a wide range of highway activities, including operation and maintenance and capital improvements. Changes in highway finance directly affect the performance of the highway system. For example, the dramatic increases in petroleum prices that occurred in the mid and late

1970's severely impacted highway programs and conditions. The after effects of inflated highway costs and reduced financial resources are still visible today.

Total highway revenue collections and disbursements reached record highs in 1984. Substantial new revenues were generated by the 1982 Surface Transportation Assistance Act and by an unprecedented number of State highway user tax increases in recent years. Consequently, collections for highway purposes by all units of government exceeded $53 billion in 1984, up more than $13 billion during the last 4 years. Federal and State revenue generating efforts have been equally responsible for the overall growth in highway funds since 1982. Federal receipts accounted for an estimated 26.4 percent of all highway revenues in 1984. This returned the Federal percent to its average over the past two decades, as compared to an all time low of 23.0 percent in 1982.

If the effects of inflation are taken into consideration (as measured by the Bid Price Index (BPI)), highway revenues in 1984 were worth little more than the $11.5 billion collected in 1960. Inflation of highway construction costs in the past 24 years has nearly matched the growth of total revenues made available for highway purposes during the same period. However, since 1980 the BPI has declined appreciably while revenues have increased steadily. Thus, the constant dollar growth of highway funds averaged 9 percent annually during that 4-year period with most of the growth occurring in the last 2 years.

Total disbursements for highways in 1984 (excluding debt retirement) were 21 percent higher than they were in 1982. Federal disbursements, bolstered by the passage of the 1982 STAA, were 27 percent higher in 1984 than they were just 2 years earlier. Capital outlays for all roads (local and nonlocal) commanded nearly 48 percent of all disbursements in 1984, up from 44 percent in 1982, and roughly equal to the 48.5 percent share in 1980. It is estimated that nearly $25 billion was expended for capital improvements in 1984, $4.3 billion more than for the previous year, and $5.8 billion more than in 1982. In constant dollars, the 2-year growth was 24 percent.

Direct imposts by highway users accounted for almost 62 percent of all highway revenue in 1984. In past years, highway user revenues generated as much as 73 percent in 1964, and as little as 55 percent in 1982.

Based on information supplied by the State governments, virtually all of the additional capital disbursements were for roads and bridges on the Federal-aid highway system. Nearly three-fourths (74.4 percent) of all nonlocal capital funds were disbursed for Federal participating programs (Federal allocations plus State matching funds) in 1983, up 1.5 percent from 1982. The share of funds spent for non-Federal participating programs (State funds only) dropped slightly (down 0.6 percent from 1982), but grew in terms of actual dollars. There was very little change in the share of funds disbursed for 4R and other types of improvements in recent years.

HIGHWAY CONDITIONS AND PERFORMANCE

Highway performance in recent years has been significantly affected by travel growth. From mid-1979 to mid-1980 highway travel declined, and it was not until mid-1982 that total travel returned to pre-1979 levels. From 1981 through 1983 travel grew 6.4 percent, with half of all travel occurring on the Federal-aid primary highways (including the Interstate System). Based on data supplied by the State highway agencies, the percentage of Interstate pavement needing repair increased from 9 percent in 1981 to 14 percent in 1982. Data for 1983 showed that pavement improvements on arterial highways, including Interstate highways, increased enough so that no further growth in poor pavement occurred.

Growth in highway travel directly influences operating speeds and total travel time. During the 1979 oil crisis, travel was reduced and the percent of travel that occurred under congested conditions on the Interstate System declined significantly. Data for 1983 shows that congestion, particularly on both the urban and rural Interstate and other rural arterials, is again on the rise.

HIGHWAY NEEDS 1983-2000

Future needs are a function of present conditions, future travel, and levels of investment. Chapter IV quantifies future needs based on a variety of investment strategies and travel scenarios.

The States estimate that travel will increase at a rate of 2.74 percent per year through the year 2000, almost 1 trillion vehicle miles more in the year 2000 than in 1983. This estimate is consistent with published travel forecasts and is accepted as the upper level of travel for this report, although travel may exceed that level if current rates continue unabated. In order to estimate needs under more drastic assumptions, such as fuel curtailment or rapid and long-term price escalation, we have included needs estimates based on 2.0 percent growth per year. The highway deterioration from either of these travel forecasts will result in over 1 million miles of major roadways requiring work through the end of the century.

On a scale of 0-100, overall nonlocal system condition in 1983 was about 84, although it varied substantially by system. As Table I-1 indicates, through the year 2000, the cost of maintaining that overall condition will be approximately $324 billion, or $18 billion annually in 1983 dollars. Eliminating all deficiencies, where right-of-way acquisition is feasible, will cost around $481 billion, or $26.7 billion annually. As described more fully in Chapter IV, the cost of keeping the unit cost of travel the same is approximately $400 billion, or $22 billion annually, and the cost of eliminating all deficiencies, even those where right-of-way would probably be prohibitively expensive, is approximately $612 billion, or $34 billion annually. Any real cumulative investment level significantly below the cost of maintaining 1983 conditions will result, over time, in a higher cost to users and to society in general through increased vehicle operating cost, travel time, and increased capital costs due to deferring needed improvements.

None of these estimates includes bridge needs, the cost of completing the Interstate, local road needs, or construction on new alignment. Local road needs are not estimated for lack of consistent national data. New location construction is not included because we do not currently have an analytical means to estimate where, or to what extent, new construction will occur. It should be noted, however, that the $612 billion estimate mentioned in the previous paragraph is an attempt to account for some new construction needs, particularly in urban areas. Some urban areas are presently accommodating capacity needs by double decking and other highly expensive types of construction that are not normally estimated by our analytical methodology. Interstate completion and bridge needs are included in the Federal-aid chapter.

FEDERAL HIGHWAY SYSTEMS

The Federal-aid highway systems are subsets of the various functional systems. For example, the primary system is comprised of virtually all rural arterials and approximately 25 percent of urban arterials. The secondary system accounts for 92 percent of rural major collectors. The urban system is a mixture of urban arterials and collectors, representing almost 70 percent of the total urban arterial and collector mileage. Together these systems, plus the Interstate, account for 834,562 of the 1,202,111 miles of nonlocal roads, or 69 percent, and carry 93 percent of nonlocal highway travel. Local roads, which provide mainly for land access, are not included in discussions of public highways and travel.

In general, performance on the Federal-aid highway systems reflects the same degree of change since 1978 that was found on the functional systems. Interstate System pavement condition deteriorated substantially between 1978 and 1983. During this time period, the number of miles needing resurfacing or reconstruction increased approximately 2000 miles, from 4,100 in 1978 to 6,100 in 1983. However, much of the deterioration occurred prior to 1983. In that year, a substantial increase in resurfacing activity averted any further decline in Interstate pavement condition.

Travel on the Interstate System has been increasing since 1982, following a sharp decline in highway travel resulting from the 1979 oil crisis. The return of traditional travel growth rates produced increases in traffic congestion on both urban and rural Interstate highways. The result of this increased congestion was longer travel times.

The impact of declining pavement condition and increased travel times between 1980 and 1983 on user costs was significant. On both the urban and rural portions of the Interstate, user costs per mile rose approximately 5 percent, with increased travel time accounting for most of the increase. Despite the decline in pavement quality and increase in user costs, the Interstate remains in the best overall shape of all the Federal-aid systems.

The primary system (excluding Interstate) carries approximately 29 percent of all travel on 7 percent of the Nations' highway mileage. It ranks in importance only behind the Interstate System as a provider of interstate transportation. In fact, it provides the highest quality of highway service available to many rural areas of the country. In 1983 approximately 10 percent of the primary system pavement was at or below a present serviceability rating (PSR) of 2.0, indicating that resurfacing or reconstruction was necessary. Another 35 percent was still in fair condition but had reached a point where rapid deterioration was expected. The overall condition of pavement on the primary system has changed very little since 1978.

Overall congestion on the rural portions of the system remained relatively low but has been increasing steadily. In general, user costs on a per-mile basis for all non-Interstate primary mileage rose about half as much as the Interstate System.

The urban system was established in 1970 to serve the major urban centers of activity. Routes are selected by appropriate local officials, with State and Federal approval, to serve the goals and objectives of the community. The system consists of high volume streets and highways that function as freeways, expressways, other principal and minor arterials, and collectors. System realignment in 1976 made urban extensions of the secondary system eligible for inclusion into the urban system. Eighty percent of the mileage is located in urbanized areas and the remainder in small urban areas. Approximately half of the urban system mileage is located in the central city and urban fringe. The other half is suburban in location.

Approximately 13 percent, or 17,500 miles, of the urban system in 1983 had a PSR of 2.0 or below. In the near future, 58,000 miles of pavement will drop into this category. Among urban roadways, the urban system exhibited a lower degree of congestion and has not shown appreciable change in either direction since 1978.

The secondary system was established in 1944 as a farm-to-market system. It grew out of an effort, begun in the Depression, to put people to work paving rural roads. The system was realigned by Congress in 1976 to include only rural major collectors, roads that serve county seats, major farms, and some industries located in rural areas. The system carries 21 percent of all rural travel.

The secondary is in the poorest condition of all systems. Given its extent (397,000 miles) and its relatively light usage, it is not surprising that the secondary is in poor shape, particularly when other, more heavily used, roads compete for scarce funds. Almost 40 percent of the secondary paved mileage either requires, or will shortly require, capital improvement. The extent of secondary mileage with pavement in good condition has improved since 1978, reflecting a concentration of capital on 3R improvements between 1978 and 1983.

Bridge conditions vary by system, much like highway conditions. Bridges are evaluated by a sufficiency rating that determines eligibility for improvement under the bridge program. Over 30 percent of the Nation's highway bridges on major highways exhibit some type of deficiency, categorized as structural, functional, or inability to perform an essential function. 1/ Structural and deck geometry deficiencies are most common. As of December 31, 1983, some 3,400 Interstate, 20,000 primary, 30,000 secondary, and 8,850 urban bridges had sufficiency ratings establishing eligibility for replacement or rehabilitation.

Table I-2 provides estimates through 2000 for completing and maintaining the Interstate System, maintaining the primary, secondary, and urban systems, and meeting existing bridge needs.

DEMOGRAPHICS, ECONOMICS, AND HIGHWAY TRAVEL

Highway travel is a derived demand, dependent on other activities rather than an end in itself. This chapter describes the key social, economic, and demographic determinants of travel, how they changed during the 1970's and where we expect them to go as we approach the end of the century. The chapter provides a more detailed description of travel trends, including a discussion of regional shifts, and intraurban travel patterns. The chapter highlights recent trends and suggests emerging program and policy issues that may influence future Federal and State highway activities.

1/ Example: A 30-year old bridge designed and built for 10-ton loads is now required to carry 20-ton loads. Therefore, it is now structurally inadequate, although, in very good structural condition.

Table I-1
Estimated 1983-2000 Capital Investment Requirements* on all Functional Systems
(In billions of 1983 dollars)

	Full Needs **				Maintain 1983 Conditions			
Annual VMT Growth	Urban	Rural	Total	Annual	Urban	Rural	Total	Annual
2.74%	222.09	259.14	481.23	26.7	163.15	160.80	323.95	18.0
2.0%	205.98	243.32	449.30	25.0	149.29	146.77	296.06	16.5

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* Excludes Interstate completion, local road needs, bridge needs, and construction on new alignment.

** Assumes right-of-way constraints identified by States.

Table I-2
Estimated 1983-2000 Capital Requirements on Federal-Aid Systems by all Units of Government
(In billions of 1983 dollars)

Category	2.74% Annual VMT Rate	2.0% Annual VMT Rate
Interstate Completion[1]	22.0	22.0
Interstate 4R	64.3 (3.6)[2]	56.8 (3.2)
Primary	93.3 (5.2)	83.1 (4.6)
Secondary	46.6 (2.6)	41.7 (2.3)
Urban	72.7 (4.0)	67.0 (3.7)
Subtotal	298.9 (16.6)	270.6 (15.0)

Estimated Bridge Needs - October, 1984

Bridge[3]		
Interstate[4]	10.6	
Primary	10.2	
Secondary	6.6	
Urban	5.3	
Off-system	21.2	
Subtotal	53.9 (3.0)	
Total	352.8[5] (19.6)	324.5[5] (18.0)

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[1] 1985 Interstate cost to complete (as of 12/31/83 minus unobligated completion funds as of 11/84).

[2] Annualized needs in 1983 dollars. All bridge needs are included under the bridge subcategory.

[3] Existing bridge needs only.

[4] Includes an additional $8.5 billion in existing needs not eligible for the Highway Bridge Replacement and Rehabilitation Program, including deck replacement, railing, horizontal and vertical clearance, and other improvements.

[5] Totals necessary to complete and maintain the Interstate, to maintain 1983 conditions on the primary, secondary, and urban systems, and to meet existing bridge needs.

CHAPTER II
HIGHWAY FINANCE TRENDS

- Total dollars collected for highway purposes by all units of government exceeded $53 billion in 1984. Since 1980, total revenues have increased more than $13 billion, an average of 9-percent annually after inflation (constant dollars).

- Federal highway revenues, bolstered by the additional funds generated by the 1982 STAA, were nearly $3.9 billion higher in 1984 than they were in 1982. State and local governments, in comparison, provided an additional $4.3 billion and $750 million more than in 1982, respectively, for highway purposes including local road needs. Federal revenues accounted for an estimated 26.4 percent of all highway revenues in 1984 as compared to only 23.0 percent in 1982. State governments continued to generate the lion's share (nearly 50 percent) of all highway funding in 1984, while the local government share declined to 23.8 percent (down from 26.9 percent in 1982) and no longer exceeds the Federal share.

- Direct imposts on highway users collected by all levels of government accounted for more than 61 percent of all funds made available for highway use in 1984, compared to a little more than 55 percent in 1982. Other sources of highway funds which showed little or no growth during the same 2-year period, provided a smaller portion of total revenues.

- Total disbursements for highways in 1984 (including local roads) were 21 percent higher than they were 2 years earlier. Federal disbursements (grants and direct payments) were up 27 percent during the same period. In comparison, State and local disbursements grew 23 percent and 11 percent, respectively.

- Total highway capital outlays (including outlays for local roads) were 30 percent higher in 1984 than they were in 1982. In terms of constant dollars, they increased 24 percent during that period of time.

- Nearly three-fourths (74.4 percent) of all nonlocal capital funds were disbursed for Federal participating programs (Federal allocations plus State matching funds) in 1983, only slightly more than the (72.9 percent) share of funds outlayed for similar purposes in 1982. Despite the extra demand placed on State finances by the increased Federal program, State capital outlays on the Federal-aid highway systems over and above that required to match Federal-aid increased in 1983. State highway investments off the Federal aid system decreased nominally in 1983 as compared to 1982 levels.

- The share of all nonlocal capital funds used for reconstruction, resurfacing, restoration, and rehabilitation (4R) purposes changed only slightly in 1982-1983 as compared to the previous 2 years. Rural 4R outlays increased slightly while urban 4R disbursements decreased slightly. The implication is that the 1982 STAA has had little overall effect on the distribution of capital funds for various types of improvements.

- Thirty-five percent of all Federal and State capital outlays went to the Interstate System in 1982 and 1983, about the same as was expended in the previous 2-year period. Interstate completion alone represented 14 percent of total Federal and State capital outlays. Another 34 percent of all capital outlays again went for freeways, expressways and other principal arterials.

HIGHWAY REVENUES

Total dollars collected for highway purposes by all units of government exceeded $53 billion in 1984. Additional revenues generated by the 1982 STAA, together with an unprecedented number of highway user tax increases at the State level in recent years combined to increase total highway collections an average of 9.7 percent annually during 1983 and 1984, as compared to only 5.3 percent annually during 1981 and 1982. Since 1974, highway revenues have grown at an average yearly pace of 6.7 percent, despite the effects of the petroleum crises during the middle and late 1970's which reduced sales of motor fuels and, hence, resulted in lower highway-user revenues. The rate of growth since 1960 has been a remarkably similar 6.6 percent annually.

Figure II-1 illustrates the relatively steady increase in highway revenues during the past 24 years, and compares it with the pace of inflation in the highway industry (as measured by the BPI) during the same period. Although highway revenues have increased 360 percent since 1960, inflation has kept their value (in constant dollars) on a relative par with revenue collections of 24 years ago. However, since 1980 the BPI has declined appreciably while revenues have steadily increased. Thus, the constant dollar growth of highway receipts was 9 percent annually during that 4-year period.

Background

The Federal and State governments have historically relied upon road-user taxes and other similar charges, including motor fuel taxes, vehicle registration fees, certain special-use taxes, and tolls, to finance highway needs. Road-user taxes were first levied in 1919, and by 1920 all States were charging some type of user tax. The Federal Government adopted the practice in the 1930's. The Federal-Aid Highway Act of 1956 and the accompanying Revenue Act established the Highway Trust Fund, which reaffirmed the concept of a user-supported highway system. Increases in driver population and per capita travel helped these user receipts keep pace with highway needs and ahead of inflation until 1974. However, the oil embargo of 1973 and subsequent increases in the price of petroleum inspired a more fuel-efficient motor vehicle fleet. This slowed the rate of growth of total highway funds to approximately half the rate highway programmers had grown accustomed to in recent years, and were anticipating in the near future. Figure II-2 depicts trends in the growth of highway revenues by charting 4-year running averages since 1960. The highest levels of average annual growth during single 4-year periods occurred from 1965 through 1969, and from 1967 through 1971 when highway revenues increased an average of 9 percent or more annually. Subsequently, the

4.7 percent average annual growth witnessed immediately thereafter (1971 through 1975) was in sharp contrast to recent experiences of that time.

The effect of this less than expected level of user-revenues combined with a sudden jump in inflation, differed among the various State and local governments. The greatest impact was felt by the Federal highway program which had not had the benefit of a significant increase in any Federal-user taxes in over 20 years. Figure II-3 illustrates the trend in sources of Federal highway revenues since 1960, and the decreasing importance of user revenues from 1960 through 1981 as a share of total Federal funding for highways. Table II-1 shows the impact on Federal funds as a share of revenues contributed by all levels of government.

Federal highway contributions, bolstered by the addition of revenues generated by the 1982 Act, were nearly $3.9 billion higher in 1984 than they were in 1982. Federal funds accounted for an estimated 26.4 percent of all highway receipts in 1984 (see Table II-1), up from their 23.0 percent share in 1982, and very similar to the average 26.9 percent Federal share that has existed since 1960.

State highway revenues comprised about 50 percent of all highway funds in 1984, a level not significantly different from that witnessed in recent years. The growth in State highway revenues between 1982-1984 was $4.3 billion, and exceeded the additional revenues provided by the 1982 STAA.

County and municipal revenues comprised a smaller share (23.8 percent) of total highway collections in 1984 than they have the past few years. They have experienced moderate growth, an average of 5.4 percent annually since 1980, as compared to 8.2 percent annual growth during the same period for Federal and State revenues combined. The local share, however, remained higher than it was throughout the 1960's and 1970's.

Trends in Sources of Revenues

Imposts on highway users accounted for more than 61 cents of every dollar made available for highway purposes in 1984 (Figure II-4). During 1983, (the last year for which fuel data are available) 40 cents or approximately 65 percent of all highway-user revenues came from imposts on highway fuel consumption alone. Total user revenues provided a larger share of the combined highway funding pot than they did in 1982, but they did not return to their same level of prominence that existed between 1960 and the mid-1970's. General fund appropriations, property taxes, and other taxes and miscellaneous nonhighway related funds accounted for 30 percent of all highway revenues in 1984. This represented a 3.5 percent decrease from the percent share of 1982, and it at least temporarily reversed a 10-year trend of a growing amount of highway funds being derived from nonuser sources. The combined share of revenues derived from bond issues and investment income (8.6 percent in 1984) dropped 2 percent between 1982 and 1984. Lower interest rates and a healthier economy generated slightly more bond activity in recent years in terms of dollars provided, while lower interest rates combined with decreases in State trust fund balances somewhat stabilized the growth of investment income.

At the Federal level, 76.8 percent of all highway revenues were paid by highway users in 1984 as compared to 65.6 percent in 1982 (See Figure II-3). Additional user revenues provided by the 1982 Act were primarily responsible for this increase. General funds such as Department of Housing and Urban Development block grants, Federal revenue sharing, economic development funds, and other such programs generated only 14.5 percent of Federal highway funds in 1984 as compared to 21 percent in 1982. Investment income also generated a lesser share of income than it has in recent years.

There has also been some change in the relative share of State highway funds provided by various sources in recent years (see Figure II-5). Income from user imposts was responsible for essentially all growth in State highway revenues between 1982 and 1984. User revenues provided 80.5 percent of all State highway funds in 1984 as compared to 77.5 percent 2 years earlier. Revenues realized from investment income, general fund appropriations, and miscellaneous other sources remained stable or increased slightly since 1982. Proceeds from bond issues, which tend to fluctuate dramatically from year to year, decreased more than 30 percent between 1982-1983 before rising somewhat in 1984.

At the local level there has been little change in the percent of highway receipts collected from various sources (see Figure II-6). Imposts on highway users which have historically provided less than 10 percent of local highway funds, generated 5.4 percent of these funds in 1984 as compared to 4.9 percent in 1982. Investment income (2.4 percent), bond proceeds (12 percent), and combined general fund appropriations and property tax assessments, etc., (80.2 percent) also continued to provide much the same levels witnessed in the past.

Intergovernmental Transfers

Large amounts of Federal revenues, including Highway Trust Fund receipts, are distributed as grants-in-aid to State and local governments. Similarly, States transfer about 23 percent of their user revenues to local governments. County and municipal governments transfer only minor amounts of user and nonuser fees. Table II-2 provides an indication of the extent to which the various levels of government rely on intergovernmental transfers as income for their respective highway programs. In 1984, for example, net intergovernmental payments to the States were $5.3 billion, equivalent to 19.9 percent of the total revenues ($26.4 billion) the States generated on their own for highway purposes. Total highway funds available to the States exceeded $30 billion in 1984.

HIGHWAY DISBURSEMENTS

Annual disbursements for highways (including local roads) since 1960 by all levels of government are shown in Table II-3. Total disbursements in 1984 were over $49.8 billion, or 21 percent higher than they were just 2 years earlier. This increase was largely a result of the increased revenue generating efforts in recent years discussed earlier in this chapter. Federal disbursements in particular, increased by 21 percent in 1984 over 1983 levels, and were 27 percent higher than Federal disbursements made in 1982.

Investment in the Nation's highway systems includes construction and reconstruction activities, right-of-way acquisition, and other capital improvement elements commonly associated with the highway construction industry. Other disbursements for highways include daily operation and maintenance functions, such as "pothole" repair, snow removal, striping, grass cutting, highway and motor vehicle law enforcement, and highway safety activities, as well as debt service payments.

Table II-4 provides a breakdown of highway disbursements by function by all units of government since 1960. The capital improvement program commanded the greatest share of highway disbursements during the heavy Interstate System construction years of the 1960's and early 1970's. In the years that followed, however, highway capital spending already affected by inflation and less than anticipated available highway-user revenues, was further slowed because of the additional diversion of funds for noncapital purposes. Administrative operations, law enforcement and safety programs, and debt service needs combined to command a growing share of each highway dollar collected. In addition, the increasing use of State highway revenues for rapid transit and other nonhighway uses helped reduce the amount of funds available for highway capital programs. Figure II-7 illustrates that the decline in the share of highways funds for capital outlays reached a low in 1977 and again in 1982, and has increased significantly since the passage of the 1982 Act.

Nationally, interest and redemption payments on highway debt (debt service) rarely exceed 10 percent of total highway disbursements. During the 1970's, debt service averaged between 9 and 10 percent of total disbursements and has dropped only marginally (8 percent estimated for 1984) relative to other costs. The debt burden has become less of a problem in some States and has increased the amount and proportion of funds available for capital purposes. However, some States remain hard pressed to meet their debt obligations and maintain their deteriorating highway systems. Ten States need one-fourth or more of their net user-revenues to cover the cost of their debt service.

Figure II-8 illustrates the overall growth in highway disbursements since 1960 and compares it to the growth of the capital component. Total capital disbursements have decreased noticeably at times, most recently between 1980 and 1982, thus making more dramatic the large increase preliminary figures indicate occurred during 1984.

Effects of Inflation

Devaluation of highway disbursements due to inflation has had a major influence on the highway program. Between 1977 and 1980, for example, highway capital outlays increased at an unusually high rate of 55.5 percent. After calculating the effect of inflation during that same period, however, the net change was an actual decline of 4.5 percent in the value of capital disbursements. Figure II-9 compares the relative levels of capital disbursements in current dollars and in constant 1960 dollars as reflected by the Federal Highway Administration Bid Price Index (BPI), a measurement of the major cost components of highway construction. The graph illustrates that constant dollar capital investment in 1984 was the highest it has been in over a decade and represented a 24 percent increase over the value of capital expenditures reported in 1982. Inflation in the highway industry has been nominal in recent years (actually declining since 1980) and is expected to have little impact on actual (current dollar) capital outlays which were estimated in 1984 to be 30 percent above 1982 levels. The large increase expected in 1984 was the direct result of the various revenue generating efforts undertaken in recent years by all levels of government. The most significant of these measures in terms of dollars produced was the 1982 STAA.

State Capital Disbursements

Each State provides information annually describing how capital funds are disbursed (urban vs. rural, Federal aid vs. non-Federal aid, Federal participating vs. non-Federal participating, etc.), and by type of improvement and functional classification. This information is never complete. As an example, for 1983 partial information was provided by 46 States, but this information did not include disbursements made by local governments. Nevertheless, analysis of the data can indicate whether significant changes are occurring in the share of capital outlays the States are disbursing for various programs in order to meet changing highway priorities and needs.

Table II-5 indicates that 74.4 percent of all capital funds were disbursed for Federal participating programs (Federal allocations plus State matching funds) in 1983. This percent share was up slightly from 1982 levels (Table II-6) and may have been a reaction to an expanded Federal program resulting from the 1982 STAA. Consequently, non-Federal participating programs on and off the Federal-aid system in 1983 received a slightly smaller share of the total capital outlay pie, even though actual dollar disbursements increased or generally remained steady.

The share of capital funds outlayed for rural and urban areas remained relatively stable. Rural roads continued to receive nearly 60 percent of all capital funding.

Approximately 80 percent of all capital outlays were used to fund work that results in actual improvements in highway condition. Right-of-way (ROW) and preliminary engineering needs consumed 20 percent of the highway capital dollar. Table II-7 indicates that this percentage grew somewhat in rural areas in 1983.

Another way of looking at overall capital disbursements is to examine the types of improvements that have been undertaken on each of the functional systems. Similar analyses in the previous edition of this report did not include data regarding capital disbursements on toll roads. Such data are included in this report, but for purposes of comparison with 1980-1981 data reported previously, data for 1982-1983 have been computed with and without the toll road disbursements. Recent changes in the percentage distribution of State capital outlays by type of improvement are graphically illustrated in Figures II-10 (rural roads) and II-11 (urban roads). In rural areas, 4R activities in 1982-1983 combined accounted for 53.2 percent of all rural expenditures (excluding toll roads), only slightly more than the 52-percent share spent for 1980-1981. In urban areas these same 4R activities demanded a smaller combined share of total urban capital outlays (40.4 percent) than they did in rural areas for the later 2-year period. Also, urban 4R disbursements decreased somewhat from the 43.2 percent share used in 1980-1981. The reconstruction portion of these outlays decreased substantially in both rural and urban areas while the 3R portion increased by similar amounts. This is attributed to problems regarding inconsistent data reporting, and thus the combined share of the 4R improvement types is considered more meaningful.

The shares of disbursements for other types of improvements in rural areas changed very little in 1982-1983 as compared to the previous period. In urban areas, safety, environmental, and other purposes demanded 5.0 percent more of the total capital outlay pie than they did previously. Much of this increase appears to have come at the expense of urban bridge programs which received 2.7 percent less of the total than they did for 1980-1981. The reason for these shifts in share of expenditures has not been identified.

Recent changes in the percent distribution of capital disbursements by functional system are shown in Figures II-12 (rural roads) and II-13 (urban roads). No significant change appears to have occurred in rural areas regarding the share of funds disbursed for each functional system. Principal arterials, other than those on the Interstate System, continue to receive the largest share (nearly 38 percent in 1982-1983) among the various functional systems. Including the Interstate System, rural principal arterials received nearly 57 percent of all funds disbursed for rural roads. In comparison, urban principal arterials including the Interstate highways, freeways, and expressways, combined to receive almost 73 percent of all urban disbursements for highway improvements. This is down somewhat from the 78.5 percent share reported for these same functional systems in 1980-1981. Disbursements for urban minor arterials increased significantly in 1982-1983 (22.2 percent up from 15.7 percent in 1980-1981).

Tables II-8 and II-9 provide additional breakdowns of the shares of disbursements in rural and urban areas, respectively, by improvement type and functional system. The data in these tables include outlays for toll roads on the various functional systems, and thus differ somewhat from the data reported in the previous study. These tables do not include disbursements for ROW and engineering expenses which do not directly relate to actual highway improvement, nor do they include some outlays for local roads off the Federal-aid system. Also, not included are disbursements for Interstate completion purposes. Estimates of the cost-to-complete the Interstate System and obligations for that purpose are reported separately to Congress. Tables II-10 and II-11 include disbursements for Interstate completion purposes, and reflect the degree of importance that is being given to Interstate completion and to 4R activities. Thirty-five percent of all Federal and State capital disbursements went to the Interstate System in rural and urban areas combined.

Management of Future Highway Finances

A major step was taken toward improving the overall highway finance picture when the STAA of 1982 was signed into law in January 1983. It increased the Federal tax on motor fuel from 4 cents per gallon to 9 cents, providing an additional $4.4 billion each year to the Federal Highway Trust Fund. Other taxes have also been changed as a result of the Act including the heavy vehicle use tax that will collect more revenues from large trucks and trailer combinations, and thereby allocate highway costs more equitably among various users. The heavy vehicle use tax was reduced in the 1984 Deficit Reduction Act, with equivalent revenue being generated by an additional 6-cent diesel fuel tax on vehicles over 10,000 pounds gross vehicle weight.

Another significant aspect of the legislation was that it signalled a change in the longstanding Federal/State responsibilities and roles. Federal legislators, recognizing a need to protect past investments in the Interstate System, approved significant increases in the I-4R program to preserve these roads. The FY 1986 Interstate 4-R authorization of $3.150 billion, for example, will be nearly quadruple the $800 million level of 1982. The intent and overall impact of this legislation has been to concentrate Federal financial resources on the roads most critical to the movement of interstate commerce, to defense needs, and to National economic efficiency.

The level of Federal funds associated with the 1982 Act will eliminate much of the shortfall between highway needs and available revenues. Even so, the State and local governments must continue to generate increasing levels of revenues in order to ensure that highways receive adequate future funding. Exactly how big this task actually is will be discussed in Chapter IV.

Traditional sources of State highway revenues include highway user taxes on motor fuel, motor vehicle registrations, drivers licences, trip permits, oversize permits, truck weight distance taxes, and various similar taxes and fees. Motor fuel tax revenues alone have historically accounted for 50 percent of all State highway funds. During 1983, 21 States increased their tax rates on motor fuels. Three-fourths of the States have increased these taxes since January 1980. Most of these increases have been relatively small. The weighted average State fuel tax rose only 1.1 cents during 1983 and is now only 2 cents higher than in 1980. This equates to an additional $2.2 billion in additional State fuel revenue collections in 1983 over those received in 1980.

Also, many States have recognized that this traditionally flat rate tax has become somewhat inadequate during periods of rapid inflation and energy conservation. Consequently, 15 States have in recent years instituted variable motor fuel taxes that automatically fluctuate according to various inflation sensitive mechanisms. Six other States now also apply a sales tax to motor fuel and dedicate the revenue for highway purposes. Such measures are expected to help sustain future anticipated revenue levels.

Another important trend emerging among State highway finance practices is that the role of the fuel tax is beginning to diminish. Efforts in recent years to produce new revenues, while at the same time redistributing the tax burden more equitably among highway users, have caused a variety of vehicle taxes to rise dramatically in many States. Eight States passed legislation in 1983 that increased truck registration, trip permit, or distance-traveled taxes. In addition, seven States either increased taxes on axle weights or instituted additional weight enforcement practices and/or stiffer penalities for overweight trucks. Publicly and politically, these efforts to make heavier vehicles pay an equitable share of highway costs have proven relatively acceptable. In one State, for example, voters have regularly blocked all attempts to raise new revenues despite a worse than average highway financial situation. In 1983, however, they voted in favor of a 25-percent increase in truck registration fees, while again voting down a tax increase on motor fuel.

Local governments have been somewhat more inclined to return to the use of bonding in recent years. Using deficit financing to pay for highway improvements is often an acceptable alternative because the benefits derived are realized over a long period of years, and the amoritization of these costs to users over the life of the facility spreads the burden equitably. Decreases in interest rates and the overall improvement in the economy in recent years have helped to rebuild tax bases and make bonding more acceptable.

Increasingly, State policymakers are beginning to shift limited amounts of general fund revenues to highway accounts. For the most part, States are avoiding making outright grants of general funds for highway programs. Instead, they are identifying certain ad valorem tax revenues attributable to motor vehicles and motor fuels and dedicating all or portions of these revenues to highways. In a sense, they have become quasi-user revenue since they are closely allied with the cost of ownership and operation of motor vehicles. Specifically, such measures have included sales tax revenues on motor vehicles and personal property taxes on motor vehicles. While such measures have been in existence for many years, an increasing number of States are earmarking these funds for highway purposes.

Significance of New Revenues

In order to measure the level of success that can be attributed to all of the various efforts to generate additional highway revenue, it is helpful to compare increases in revenue collections with changes in highway needs and with measures of increased demand upon these revenues. Changes in needs will be discussed in Chapter IV and comparisons with revenue changes will be discussed at that point.

Just as each additional vehicle mile of travel generates new revenues, it also generates new demand upon the highway system. Thus, if the relative change in the tax effort is to be properly gauged, it makes sense to deflate the growth of highway revenues by increases in travel as well as by increases in the BPI. Figure II-14 illustrates the effect of increasing demands of highway travel and inflation between 1950 and 1984 on total highway revenues. The base year used in the graph is 1982 which coincides with the passage of the 1982 STAA.

In 1984, for example, receipts made available for highway purposes increased by 33.5 percent since 1980. In comparison, after expected changes in the BPI and VMT have been taken into consideration, this increase was devalued slightly to 28.2 percent. During this 4-year period, increases in VMT were largely offset by a decrease in the BPI. Prior to 1980, however, both factors were mostly increasing with the result that the real value of highway receipts decreased fairly steadily for 20 years (1960 through 1980). As a result, highway users today pay less than half the taxes they paid in 1960 in terms of constant dollars per VMT. To receive an equivalent constant dollar amount of revenues per VMT in 1984 as those collected in 1960 would require the equivalent of a 50-cent increase in the Federal fuel tax. This should not be interpreted to mean that the Federal fuel tax needs to be increased to 59 cents per gallon. It only serves to help put the value of recent tax increases in proper perspective, and to help explain the decline in highway conditions during the last decade.

Table II-1
Total Revenues for Highways by Government Jurisdiction for Selected Years 1960-1984[1]
(In millions of dollars)

	Federal		State		County and Municipal		
Year	Receipts	Percent	Receipts	Percent	Receipts	Percent	Total Receipts
1960	3,063	26.7	6,055	52.7	2,367	20.6	11,485
1962	3,364	26.4	6,904	54.1	2,484	19.5	12,752
1964	3,907	28.5	7,192	52.5	2,594	19.0	13,693
1966	4,720	28.6	8,723	53.8	3,072	18.6	16,515
1968	5,064	27.2	10,036	53.8	3,534	19.0	18,634
1970	6,144	28.2	11,737	54.0	3,866	17.8	21,747
1971	6,584	27.1	13,359	55.1	4,317	17.8	24,260
1972	6,286	25.7	13,551	55.3	4,646	19.0	24,483
1973	7,419	27.8	14,288	53.5	4,996	18.7	26,703
1974	7,846	28.5	14,238	51.6	5,498	19.9	27,582
1975	7,676	26.3	15,105	51.8	6,379	21.9	29,160
1976	8,038	26.1	16,126	52.3	6,667	21.6	30,831
1977	9,230	27.8	16,700	50.2	7,313	22.0	33,234
1978	9,750	27.5	17,766	50.0	7,988	22.5	35,504
1979	10,560	27.7	18,507	48.6	9,018	23.7	38,085
1980	9,830	24.8	19,666	49.5	10,219	25.7	39,715
1981	10,338	24.2	21,044	49.3	11,311	26.5	42,693
1982	10,110	23.0	22,078	50.1	11,867	26.9	44,075
1983	11,734	24.6	23,885	50.0	12,153	25.4	47,772
1984[2]	13,998	26.4	26,392	49.8	12,620	23.8	53,010
Average		26.9		52.1		21.0	

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[1] Highway Statistics, HF-11.

[2] Preliminary.

Table II-2
Receipts from Intergovernmental Transfers as a Percent of Local and State Receipts (1960-1984)[1]

Year	State	County	Municipal
1960	22.9	94.0	24.1
1961	24.5	89.3	23.2
1962	24.7	84.1	26.9
1963	33.2	91.2	27.3
1964	35.1	98.0	33.0
1965	30.8	97.0	34.0
1966	29.8	89.9	31.3
1967	25.4	86.3	32.1
1968	25.7	85.7	32.6
1969	19.0	92.7	35.2
1970	20.0	97.3	41.8
1971	20.0	92.7	37.0
1972	16.4	95.3	37.0
1973	11.3	111.0	42.3
1974	15.0	108.6	39.7
1975	20.0	94.6	34.8
1976	20.7	96.0	34.6
1977	16.1	93.4	36.9
1978	17.2	97.2	35.1
1979	23.1	83.8	39.8
1980	30.0	78.8	32.4
1981	21.2	78.9	31.4
1982	17.0	78.8	32.4
1983	15.6	90.1	33.7
1984[2]	19.9	96.3	35.6

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[1] Highway Statistics, HF-11.

[2] Preliminary.

Table II-3
Total Disbursements for Highways by all Levels of Government[1/] [2/]
(In millions of dollars)

	Federal		State		Local		Total	
Year	Amount	Percent Change[3/]	Amount	Percent Change[3/]	Amount	Percent Change[3/]	Amount	Percent Change[3/]
1960	2,753	-14.95	5,438	6.54	1,969	1.76	10,160	-1.13
1961	2,941	6.83	5,818	6.99	2,068	5.03	10,827	6.56
1962	3,173	7.89	6,314	8.53	2,136	3.29	11,623	7.35
1963	3,759	18.47	6,395	1.28	2,166	1.40	12,320	6.00
1964	4,278	13.59	6,548	2.39	2,159	-0.32	12,985	5.40
1965	4,137	-3.30	7,065	7.90	2,254	4.40	13,456	3.63
1966	4,610	11.43	7,643	8.18	2,530	12.24	14,783	9.86
1967	4,390	-4.77	8,507	11.30	2,807	10.95	15,704	6.23
1968	4,822	9.84	9,069	6.61	3,021	7.62	16,912	7.69
1969	4,557	-5.50	9,842	8.52	3,205	6.09	17,604	4.09
1970	5,200	14.11	10,970	11.46	3,413	6.49	19,583	11.24
1971	5,658	8.81	11,760	7.20	3,781	10.78	21,199	8.25
1972	5,428	-4.07	12,548	6.70	3,953	4.55	21,929	3.44
1973	5,440	0.22	13,281	5.84	4,067	2.88	22,788	3.92
1974	6,155	13.14	13,696	3.12	4,821	18.54	24,672	8.27
1975	7,224	17.37	14,263	4.14	5,720	18.65	27,207	10.27
1976	7,853	8.71	13,964	-2.10	5,921	3.51	27,738	1.95
1977	7,621	-2.96	14,365	2.55	6,198	4.68	28,184	1.97
1978	8,397	10.18	16,248	13.11	7,196	16.10	31,841	12.98
1979	10,200	21.47	17,870	9.98	7,623	5.93	35,693	12.10
1980	11,826	15.94	19,020	6.44	9,238	21.19	40,084	12.30
1981	11,097	-6.16	19,371	1.85	9,956	7.77	40,424	0.85
1982	10,504	-5.34	20,167	4.11	10,610	6.57	41,281	2.12
1983	11,005	4.77	21,989	9.20	10,966	3.36	43,960	6.49
1984[4/]	13,293	20.79	24,811	12.83	11,741	7.07	49,845	13.39

[1/] Highway Statistics, HF-11, HF-12.

[2/] Excludes debt retirement, but includes interest on debt.

[3/] From previous year.

[4/] Preliminary.

Table II-4
Disbursements for Highways by Functions[1/]
All Units of Governments
(In millions of dollars)

Year	Capital Outlay	Maintenance and Operation	Administration etc.	Highway Patrol and Safety	Interest on Debt	Subtotal Current Disbursements	Debt Retirement	Total
1960	6,290	2,640	483	327	420	10,160	601	10,761
1961	6,800	2,728	522	348	429	10,827	665	11,492
1962	7,386	2,839	537	383	478	11,623	679	12,302
1963	7,893	2,918	586	423	500	12,320	732	13,052
1964	8,252	3,060	684	474	515	12,985	752	13,737
1965	8,368	3,289	751	524	524	13,456	855	14,311
1966	9,246	3,517	815	669	536	14,783	915	15,698
1967	9,661	3,772	906	777	588	15,704	965	16,669
1968	10,346	4,003	1,017	940	606	16,912	1,071	17,983
1969	10,373	4,331	1,110	1,109	681	17,604	1,170	18,774
1970	11,575	4,720	1,275	1,303	710	19,583	1,252	20,835
1971	12,306	5,114	1,436	1,503	840	21,199	1,281	22,480
1972	12,275	5,443	1,600	1,671	950	21,929	1,270	23,199
1973	12,165	5,949	1,735	1,891	1,041	22,788	1,405	24,193
1974	13,102	6,573	1,857	2,061	1,079	24,672	1,445	26,117
1975	14,398	7,286	1,981	2,431	1,129	27,207	1,492	28,699
1976	13,927	7,735	2,209	2,633	1,234	27,738	1,567	29,305
1977	13,079	8,612	2,370	2,842	1,281	28,184	1,648	29,832
1978	14,938	9,785	2,590	3,160	1,368	31,841	1,593	33,434
1979	17,612	10,571	2,726	3,359	1,425	35,693	1,751	37,444
1980	20,337	11,445	3,022	3,824	1,456	40,084	1,711	41,795
1981	19,734	12,165	3,439	3,884	1,202	40,424	2,464	42,888
1982	19,052	13,319	3,152	4,068	1,690	41,281	2,046	43,327
1983	20,540	14,015	3,276	4,257	1,872	43,960	2,184	46,144
1984[2/]	24,878	14,933	3,484	4,585	1,965	49,845	2,213	52,058

[1/] *Highway Statistics*, HF-10, HF-12.

[2/] Preliminary.

Table II-5
1983 State Highway Capital Expenditures[1] [2]
On and Off the Federal-aid System
(In millions of dollars)

	On Federal-Aid System			
	Federal[3] Participating	Non Federal Partici- pating	Off Federal-aid System	Total
Rural Disbursements	5,307.1	1,677.7	465.1	7,449.9
Percent by program	71.2	22.5	6.3	100.0
Percent rural of total disbursements	56.8	63.8	79.1	59.3
Urban Disbursements	4,039.4	953.3	123.1	5,115.8
Percent by program	79.0	18.6	2.4	100.0
Percent urban of total disbursements	43.2	36.2	20.9	40.7
Total Disbursements	9,346.5	2,631.0	588.2	12,565.7
Percent by program	74.4	20.9	4.7	100.0

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[1] As reported for 46 States including the District of Columbia; represents incomplete data reported for several States. Expenditures by local governments not included.

[2] Includes right-of-way and preliminary engineering costs. Also includes expenditures on toll roads.

[3] Totals include Federal matching funds.

Table II-6
1982 State Highway Capital Expenditures[1] [2]
On and Off the Federal-aid System
(In millions of dollars)

	On Federal-Aid System			
	Federal[3] Participating	Non Federal Partici-pating	Off Federal-aid System	Total
Rural Disbursements	4,362.6	1,485.6	422.1	6,270.3
Percent by program	69.6	23.7	6.7	100.0
Percent rural of total disbursements	56.9	65.7	71.6	59.6
Urban Disbursements	3,306.3	777.0	167.3	4,250.6
Percent by program	77.8	18.3	3.9	100.0
Percent urban of total disbursements	43.1	34.3	28.4	40.4
Total Disbursements	7,668.9	2,262.6	589.4	10,520.9
Percent by program	72.9	21.5	5.6	100.0

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[1] As reported for 47 States including the District of Columbia; represents incomplete data reported for several States. Expenditures by local governments not included.

[2] Includes right-of-way and preliminary engineering costs. Also includes expenditures on toll roads.

[3] Totals include Federal matching funds.

Table II-7
Comparison of 1982 and 1983 State Highway Capital Disbursements[1/] for Condition Improvements and ROW and Engineering
(In millions of dollars)

	1982		1983		
	Dollars	Percent	Dollars	Percent	Total 1982-1983 Disburse-ments
Rural Disbursements					
Condition Improvements	5,223.8	49.7	6,058.9	48.2	11,282.7[2/]
ROW and Engineering	1,046.5	9.9	1,391.0	11.1	2,437.5
Total Rural	6,270.3	59.6	7,449.9	59.3	13,720.2
Urban Disbursements					
Condition Improvements	3,234.0	30.7	3,955.8	31.5	7,189.8[3/]
ROW and Engineering	1,016.6	9.7	1,160.0	9.2	2,176.6
Total Urban	4,250.6	40.4	5,115.8	40.7	9,366.4
Rural and Urban Disbursements					
Condition Improvements	8,457.8	80.4	10,014.7	79.7	18,472.5
ROW and Engineering	2,063.1	19.6	2,551.0	20.3	4,614.1
Total Rural and Urban	10,520.9	100.0	12,565.7	100.0	23,086.6

[1/] As reported for 47 States in 1982, and 46 States in 1983; both years include the District of Columbia. Disbursements by local governments not included.

[2/] Includes disbursements of $210.2 million on local roads not included in Table II-10.

[3/] Includes disbursements of $131.1 million on local roads not included in Table II-11.

Table II-8
Rural Disbursements by Federal and State Governments, by Improvement Type and Functional System 1982-1983
(not including disbursements for Interstate completion purposes)

FUNCTIONAL SYSTEM

Type of Improvement	Interstate	Other Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Total
New Construction	116,000	1,241,145	363,917	305,820	49,605	2,076,487
% by Functional System	5.6	59.8	17.5	14.7	2.4	100.0
% of All Improvements	5.3	33.8	17.5	17.7	15.8	20.8
% of Total Expenditures	1.2	12.4	3.6	3.1	0.5	20.8
Reconstruction	273,285	772,859	335,782	193,532	29,275	1,624,733
% by Functional System	16.8	47.6	21.9	11.9	1.8	100.0
% by All Improvements	12.4	21.0	17.1	11.2	9.3	16.2
% of Total Expenditures	2.7	7.7	3.6	1.9	0.3	16.2
Major Widening	94,409	239,829	78,304	22,999	756	436,297
% by Functional System	21.6	55.0	17.9	5.3	0.2	100.0
% of All Improvements	4.3	6.5	3.8	1.4	0.2	4.4
% of Total Expenditures	0.9	2.4	0.8	0.2	0.0	4.4
RRR	1,323,022	915,286	796,052	708,961	149,388	3,892,709
% by Functional System	34.0	23.5	20.5	18.2	3.8	100.0
% of All Improvements	60.2	24.9	38.4	41.1	47.5	39.0
% of Total Expenditures	13.2	9.2	8.0	7.1	1.5	39.0
Bridge	157,652	338,351	333,908	336,553	62,997	1,229,461
% by Functional System	12.8	27.5	27.2	27.4	5.1	100.0
% of All Improvements	7.2	9.2	16.1	19.5	20.0	12.3
% of Total Expenditures	1.6	3.4	3.3	3.4	0.6	12.3
Safety and Other	232,375	170,261	148,146	156,700	22,552	730,034
% by Functional System	31.8	23.3	20.3	21.5	3.1	100.0
% of All Improvements	10.6	4.6	7.1	9.1	7.2	7.3
% of Total Expenditures	2.3	1.7	1.5	1.6	0.2	7.3
Total	2,196,743	3,677,731	2,076,109	1,724,565	314,573	9,989,721
% by Functional System	22.0	36.8	20.8	17.3	3.1	100.0
% of All Improvements	100.0	100.0	100.0	100.0	100.0	100.0
% of Total Expenditures	22.0	36.8	20.8	17.3	3.1	100.0

Table II-9
Urban Disbursements by Federal and State Governments, by Improvement Type and Functional System 1982-1983
(not including disbursements for Interstate completion purposes)

	FUNCTIONAL SYSTEM					
Types of Improvements	Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors	Total
New Construction	94,270	509,721	427,192	223,884	56,770	1,311,837
% by Functional System	7.2	38.8	32.6	17.1	4.3	100.0
% of All Improvements	5.7	52.5	27.5	18.8	20.6	23.2
% of Total Expenditures	1.7	9.0	7.6	4.0	1.0	23.2
Reconstruction	317,034	97,651	215,385	185,327	37,766	853,163
% by Functional System	37.2	11.5	25.2	21.7	4.4	100.0
% of All Improvements	19.1	10.1	13.9	15.5	13.7	15.1
% of Total Expenditures	5.6	1.7	3.8	3.3	0.7	15.1
Major Widening	69,551	72,902	178,196	130,818	18,709	470,176
% by Functional System	14.8	15.5	37.9	27.8	4.0	100.0
% of All Improvements	4.2	7.5	11.5	11.0	6.8	8.3
% of Total Expenditures	1.2	1.3	3.2	2.3	0.3	8.3
RRR	707,722	168,967	257,075	241,633	75,438	1,450,835
% by Functional System	48.8	11.6	17.7	16.7	5.2	100.0
% of All Improvements	42.8	17.4	16.6	20.2	27.4	25.7
% of Total Expenditures	12.5	3.0	4.6	4.3	1.3	25.7
Bridge	187,445	50,318	298,169	118,885	36,338	691,155
% by Functional System	27.1	7.3	43.1	17.2	5.3	100.0
% of All Improvements	11.3	5.2	19.2	10.0	13.2	12.3
% of Total Expenditures	3.3	0.9	5.3	2.1	0.6	12.3
Safety and Other	279,071	71,093	175,071	292,912	50,289	868,436
% by Functional System	32.1	8.2	20.2	33.7	5.8	100.0
% of All Improvements	16.9	7.3	11.3	24.5	18.3	15.4
% of Total Expenditures	4.9	1.3	3.1	5.2	0.9	15.4
Total	1,655,093	970,652	1,551,088	1,193,459	275,310	5,645,602
% by Functional System	29.3	17.2	27.5	21.1	4.9	100.0
% of All Improvements	100.0	100.0	100.0	100.0	100.0	100.0
% of Total Expenditures	29.3	17.2	27.5	21.1	4.9	100.0

Table II-10
Rural Disbursements by Federal and State Governments, by Improvement Type and Functional System 1982-1983[1]

	FUNCTIONAL SYSTEM					
Type of Improvement	Interstate	Other Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Total
New Construction	1,198,828	1,241,145	363,917	305,820	49,605	3,159,315
% by Functional System	37.9	39.3	11.5	9.7	1.6	100.0
% of All Improvements	36.6	33.8	17.5	17.7	15.8	28.5
% of Total Expenditures	10.8	11.2	3.3	2.8	0.4	28.5
Reconstruction	273,285	772,859	355,782	193,532	29,275	1,624,733
% by Functional System	16.8	47.6	21.9	11.9	1.8	100.0
% of All Improvements	8.3	21.0	17.1	11.2	9.3	14.7
% of Total Expenditures	2.5	7.0	3.2	1.7	0.3	14.7
Major Widening	94,409	239,829	78,304	22,999	756	436,297
% by Functional System	21.6	55.0	17.9	5.3	0.2	100.0
% of All Improvements	2.9	6.5	3.8	1.4	0.2	3.9
% of Total Expenditures	0.9	2.2	0.7	0.2	0.0	3.9
RRR	1,323,022	915,286	796,052	708,961	149,388	3,892,709
% by Functional System	34.0	23.5	20.5	18.2	3.8	100.0
% of All Improvements	40.3	24.9	38.4	41.1	47.5	35.2
% of Total Expenditures	11.9	8.3	7.2	6.4	1.3	35.2
Bridge	157,652	338,351	333,908	336,553	62,997	1,229,461
% by Functional System	12.8	27.5	27.2	27.4	5.1	100.0
% of All Improvements	4.8	9.2	16.1	19.5	20.0	11.1
% of Total Expenditures	1.4	3.1	3.0	3.0	0.6	11.1
Safety and Other	232,275	170,261	148,146	156,700	22,552	730,034
% by Functional System	31.8	23.3	20.3	21.5	3.1	100.0
% of All Improvements	7.1	4.6	7.1	9.1	7.2	6.6
% of Total Expenditures	2.1	1.5	1.3	1.4	0.2	6.6
Total	3,279,571	3,677,731	2,076,109	1,724,565	314,573	11,072,549
% by Functional System	29.6	33.2	18.8	15.6	2.8	100.0
% of All Improvements	100.0	100.0	100.0	100.0	100.0	100.0
% of Total Expenditures	29.6	33.2	18.8	15.6	2.8	100.0

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[1] Percentages reflect disbursements for Interstate completion.

Table II-11
Urban Disbursements by Federal and State Governments, by Improvement Type and Functional System 1982-1983[1]

Types of Improvements	FUNCTIONAL SYSTEM Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors	Total
New Construction	1,507,331	509,721	427,192	223,884	56,770	2,724,898
% by Functional System	55.3	18.7	15.7	8.2	2.1	100.0
% of All Improvements	49.1	52.5	27.5	18.8	20.6	38.6
% of Total Expenditures	21.4	7.2	6.1	3.2	0.8	38.6
Reconstruction	317,034	97,651	215,385	185,327	37,766	853,163
% by Functional System	37.2	11.5	25.2	21.7	4.4	100.0
% of All Improvements	10.3	10.1	13.9	15.5	13.7	12.1
% of Total Expenditures	4.5	1.4	3.1	2.6	0.5	12.1
Major Widening	69,551	72,902	178,196	130,818	18,709	470,176
% by Functional System	14.8	15.5	37.9	27.8	4.0	100.0
% of All Improvements	2.3	7.5	11.5	11.0	6.8	6.7
% of Total Expenditures	1.0	1.0	2.5	1.9	0.3	6.7
RRR	707,722	168,967	257,075	241,633	75,438	1,450,835
% by Functional System	48.8	11.6	17.7	16.7	5.2	100.0
% of All Improvements	23.1	17.4	16.6	20.2	27.4	20.5
% of Total Expenditures	10.0	2.4	3.6	3.4	1.1	20.5
Bridge	187,445	50,318	298,169	118,885	36,338	691,155
% by Functional System	27.1	7.3	43.1	17.2	5.3	100.0
% of All Improvements	6.1	5.2	19.2	10.0	13.2	9.8
% of Total Expenditures	2.7	0.7	4.2	1.7	0.5	9.8
Safety and Other	279,071	71,093	175,071	292,912	50,289	868,436
% by Functional System	32.1	8.2	20.2	33.7	5.8	100.0
% of All Improvements	9.1	7.3	11.3	24.5	18.3	12.3
% of Total Expenditures	4.0	1.0	2.5	4.1	0.7	12.3
Total	3,068,154	970,652	1,551,088	1,193,459	275,310	7,058,663
% by Functional System	43.5	13.7	22.0	16.9	3.9	100.0
% of All Improvements	100.0	100.0	100.0	100.0	100.0	100.0
% of Total Expenditures	43.5	13.7	22.0	16.9	3.9	100.0

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[1] Percentages reflect disbursements for Interstate completion.

Figure II-1

Comparison of Percent Growth in Highway Receipts and the Bid Price Index - 1960-1984

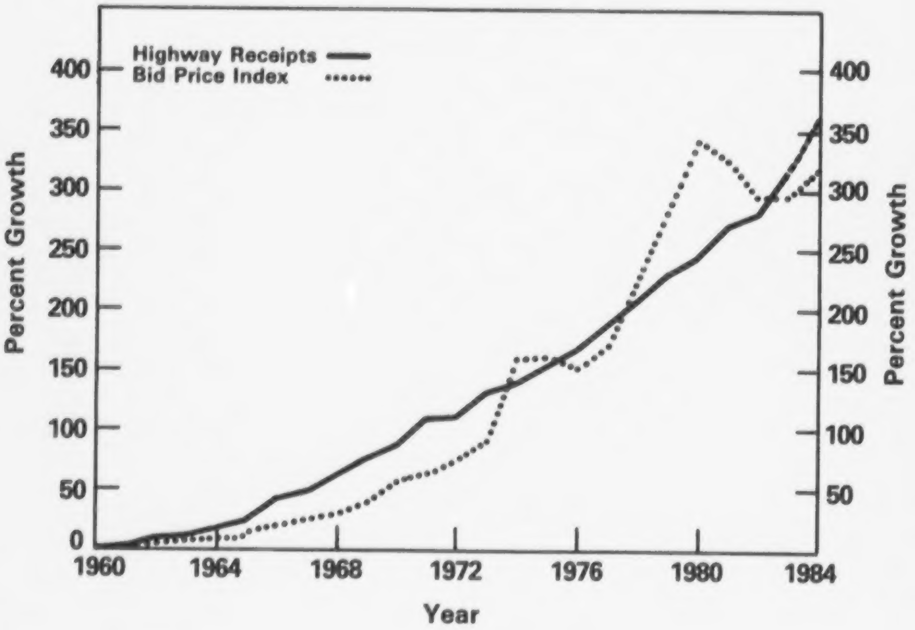


Figure II-2

Average Annual Growth of Highway Receipts During Four Year Periods 1960-1984

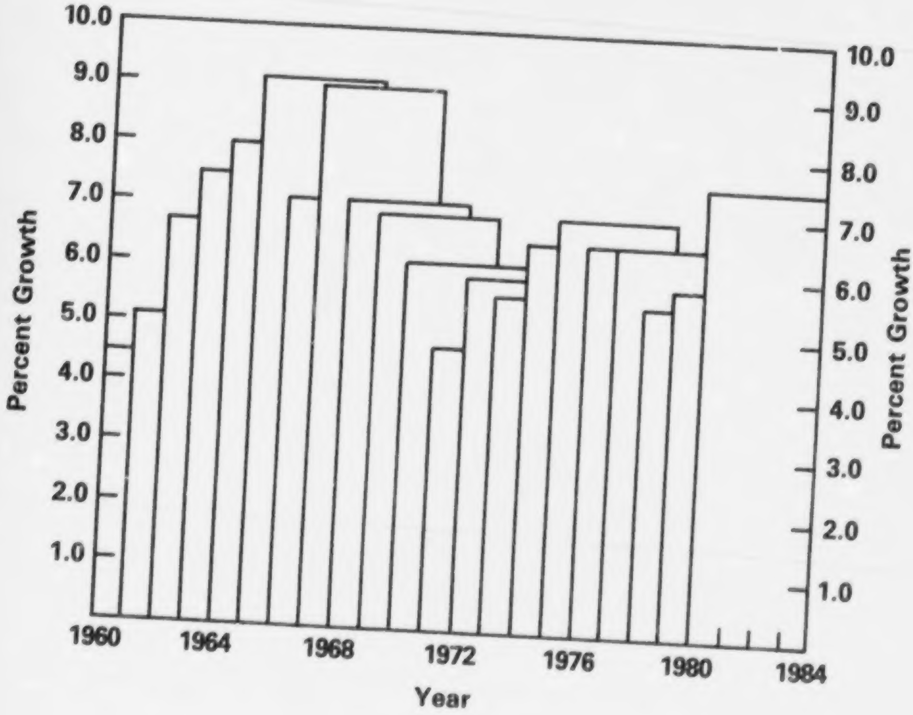


Figure II-3

Trends in Sources of Federal Highway Revenues 1960-1984

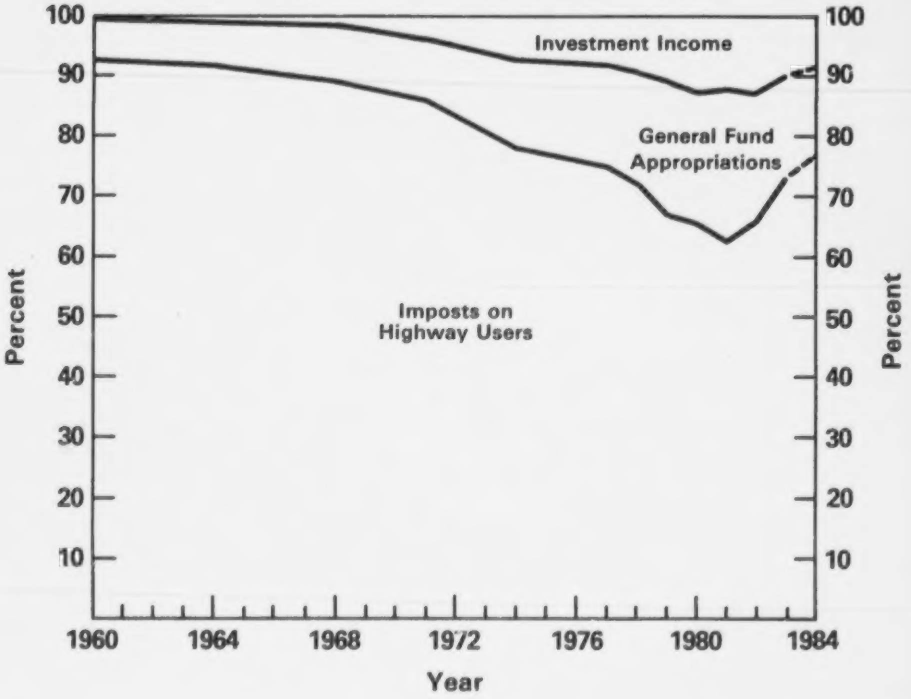


Figure II-4

Trends in Sources of Revenues Collected for Highways by All Levels of Government 1960-1984

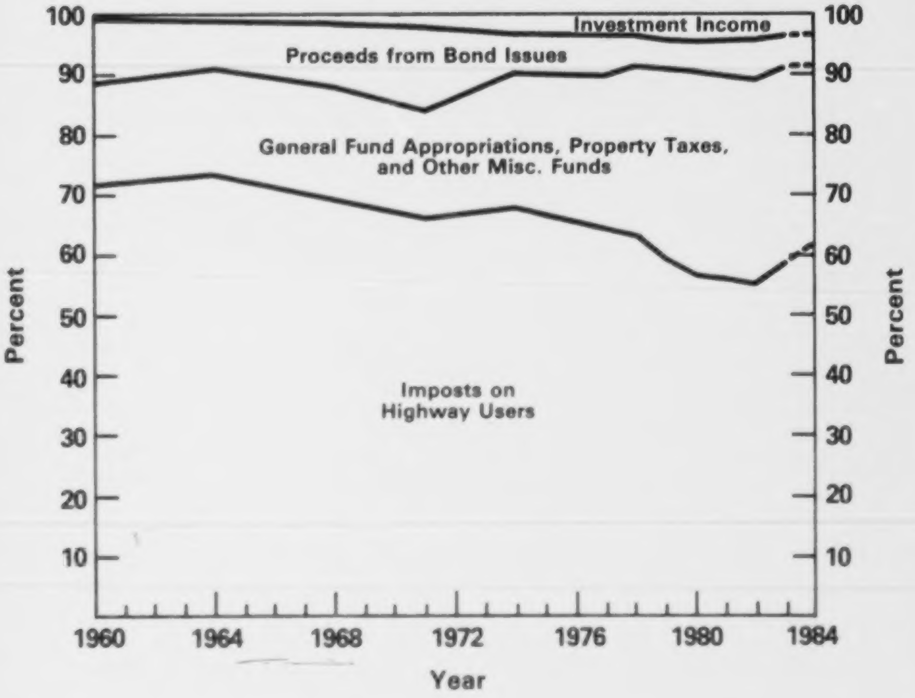


Figure II-5

Trends in Sources of State Highway Revenues 1960-1984

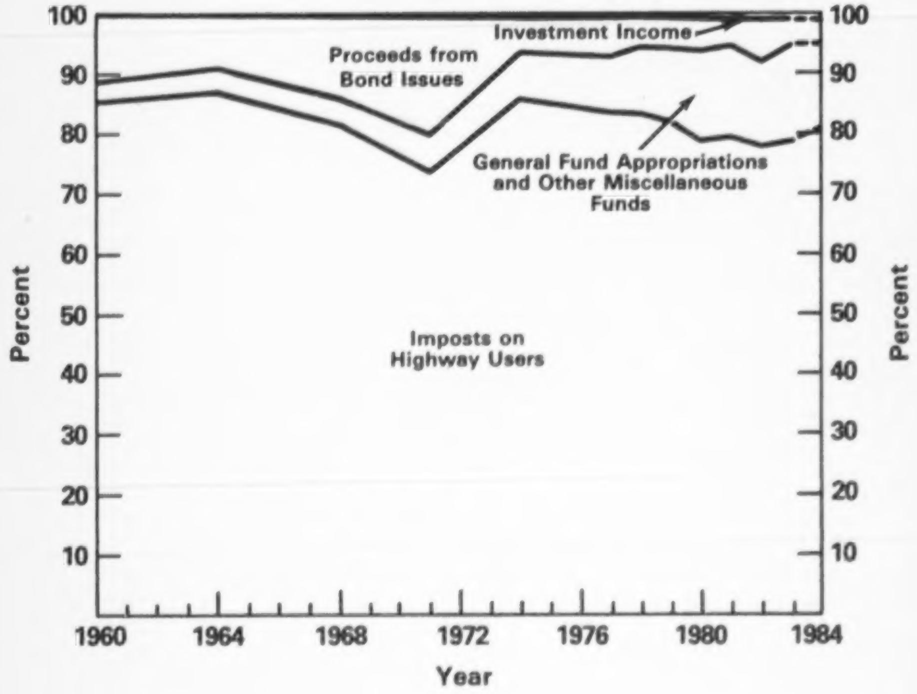


Figure II-6

Trends in Sources of Local Highway Revenues 1960-1984

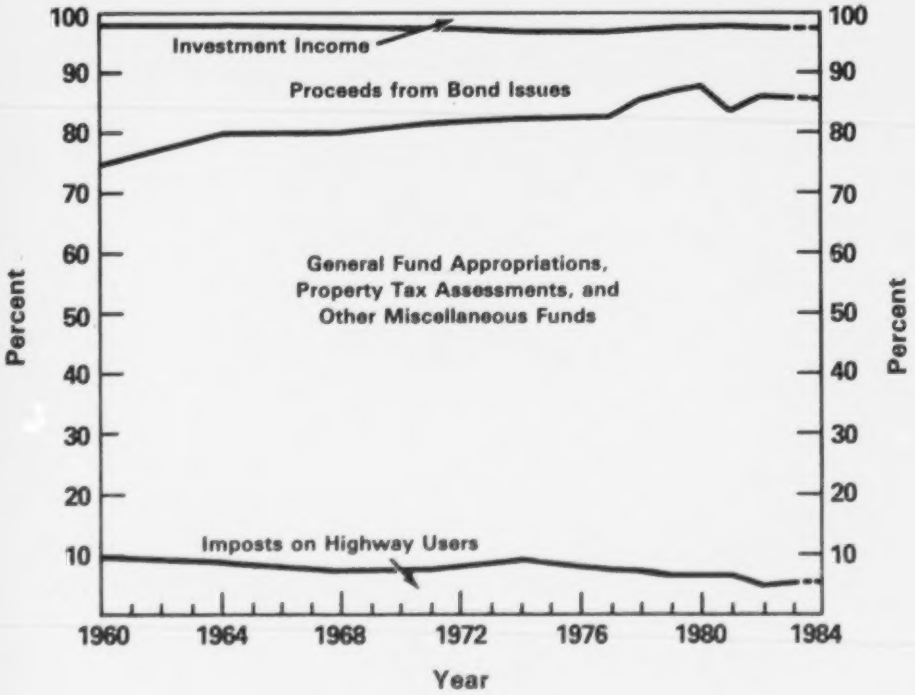


Figure II-7

Distribution of Total Highway Disbursements

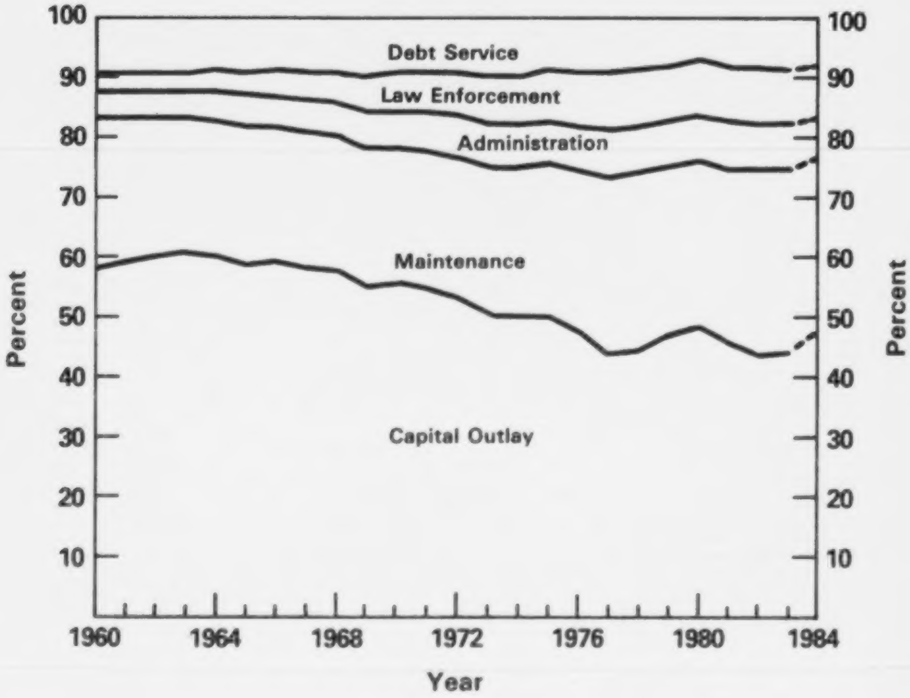


Figure II-8

Total Highway Disbursements and the Capital Program (1960-1984)

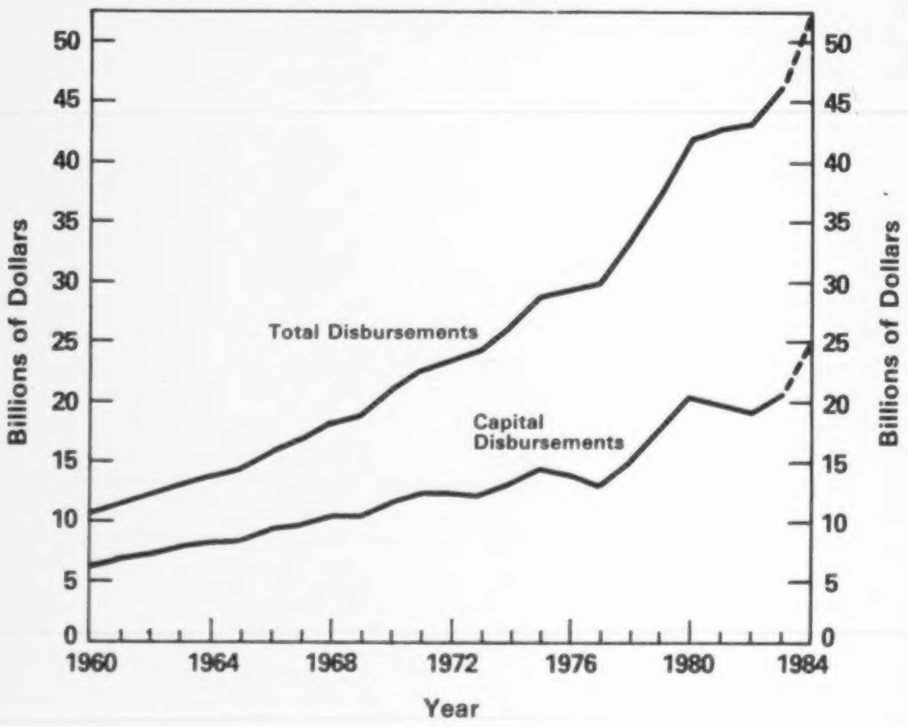


Figure II-9

Capital Disbursements by All Levels of Government in Current and Constant Dollars (1960-1984)

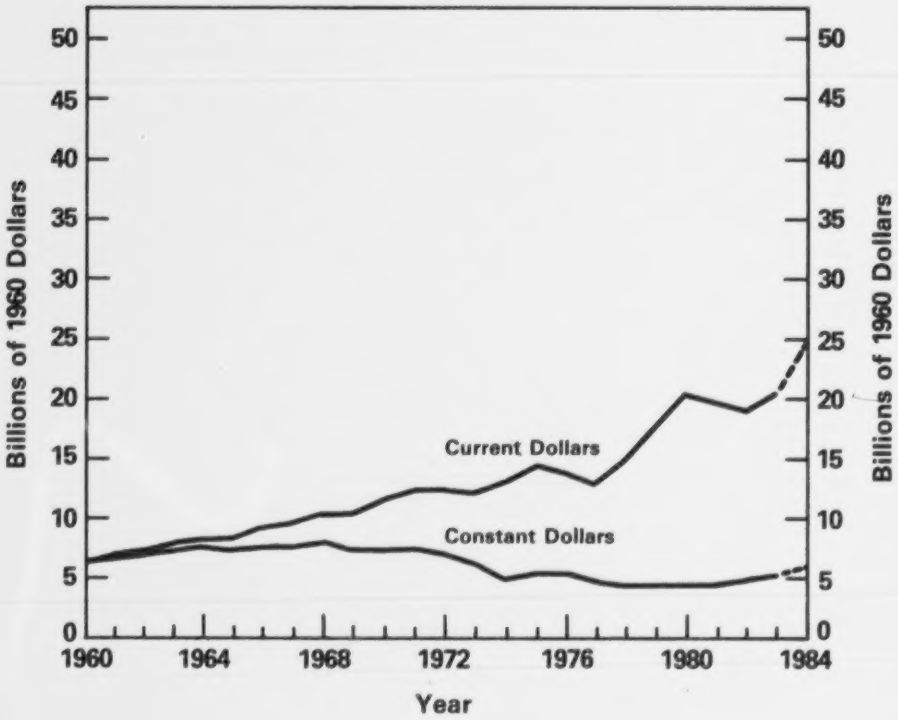
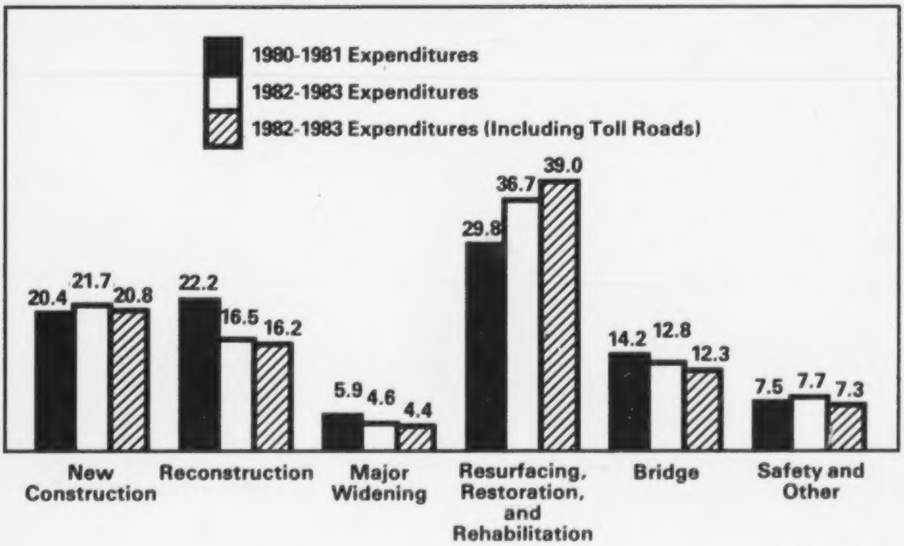


Figure II-10
Rural

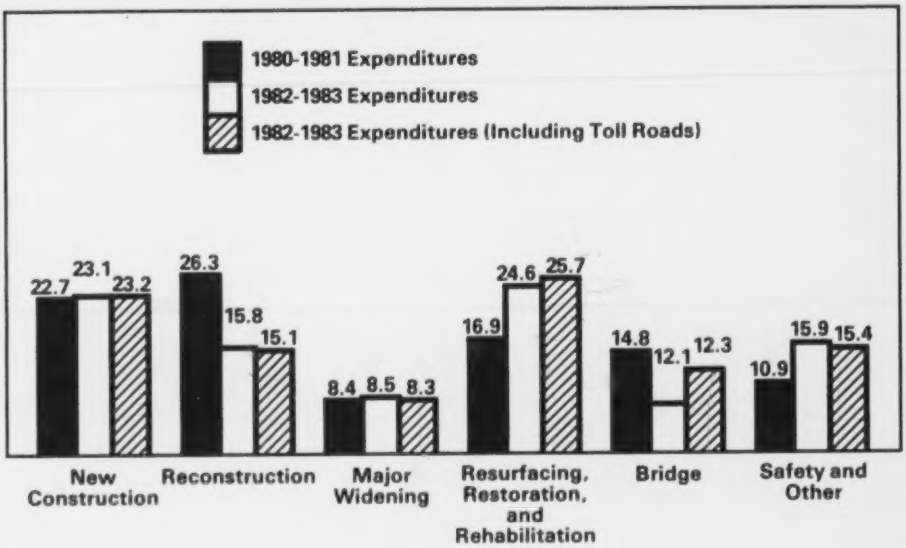
Recent Changes in the Percent Distribution of State Capital Expenditures byType of Improvement[1]



[1] Percentages do not reflect disbursements for Interstate completion purposes.

Figure II-11
Urban

Recent Changes in the Percent Distribution of State Capital Expenditures byType of Improvement[1]



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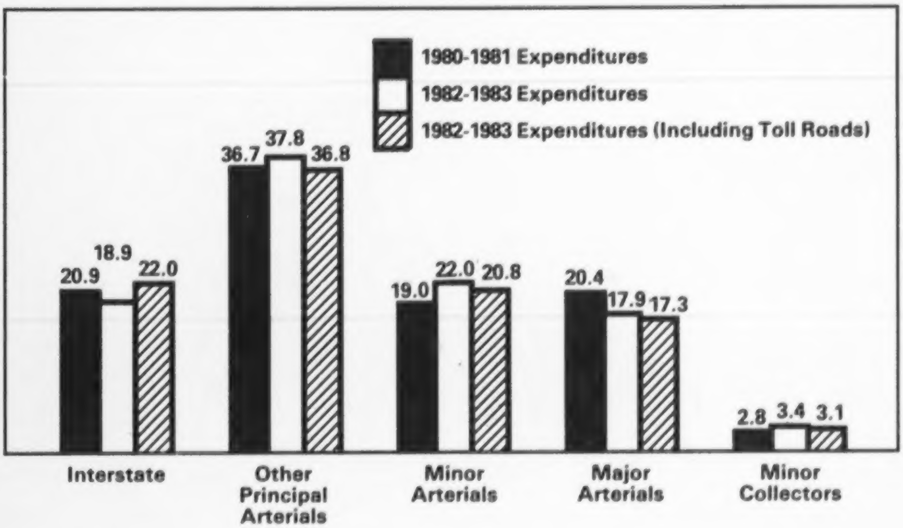
[1] Percentages do not reflect disbursements for Interstate completion purposes.

Figure II-12
Rural

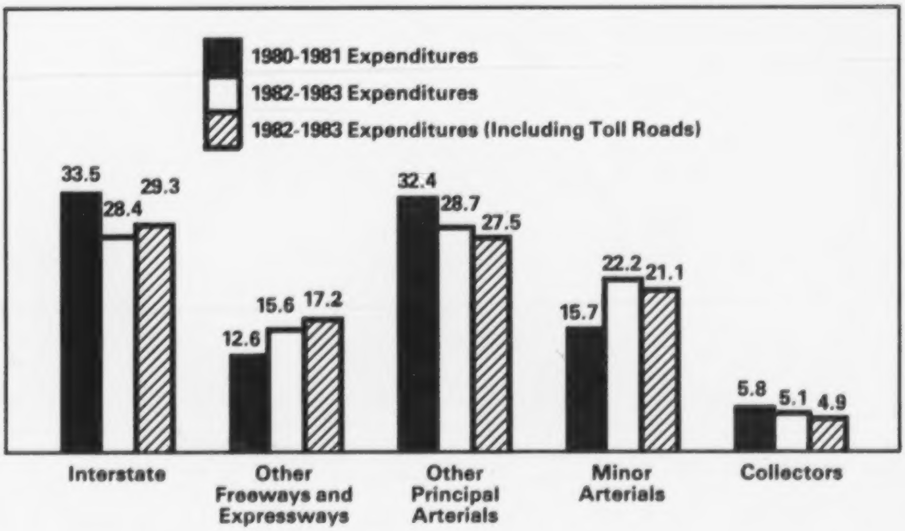
Recent Changes in the Percent Distribution of State Capital Expenditures by Functional System [1]



[1] Percentages do not reflect disbursements for Interstate completion purposes.

Figure II-13
Urban

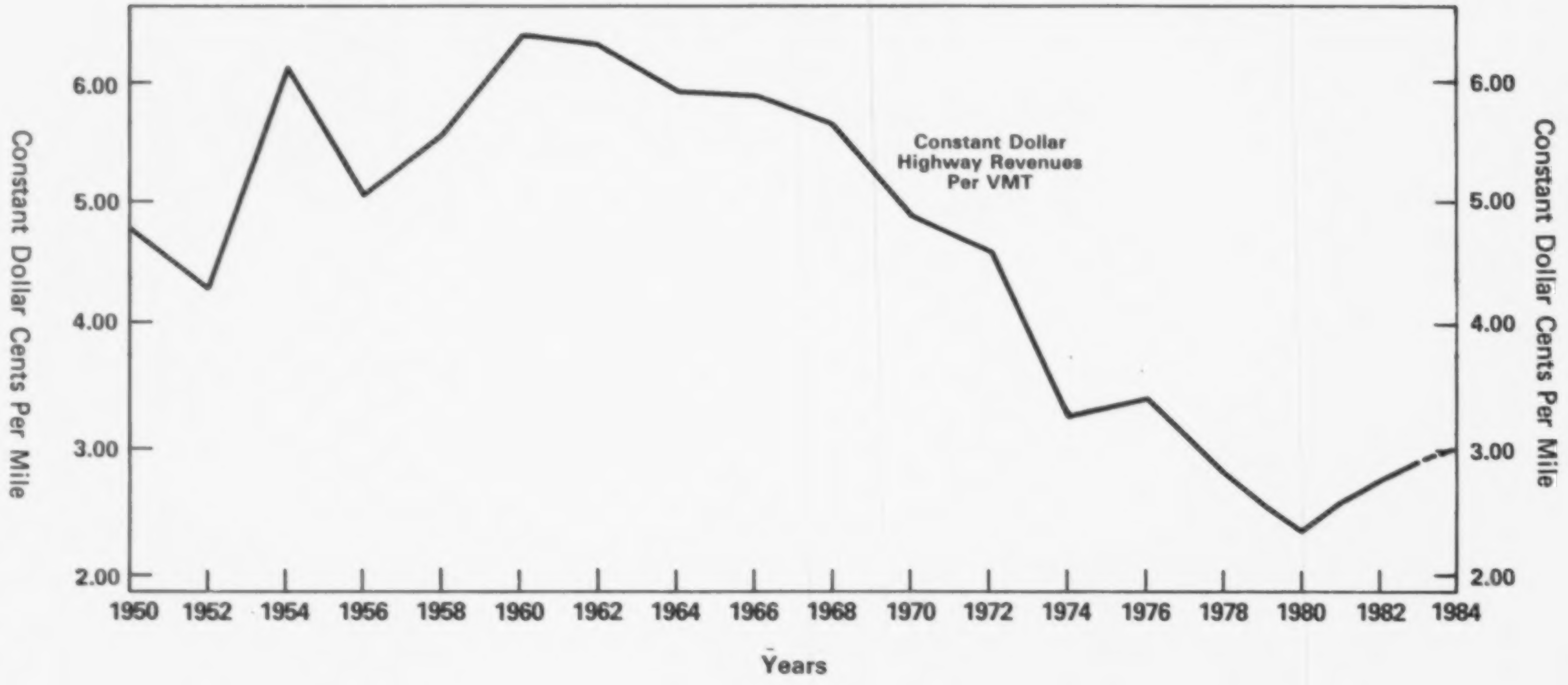
Recent Changes in the Percent Distribution of State Capital Expenditures by Functional System[1]



[1] Percentages do not reflect disbursements for Interstate completion purposes.

Figure II-14

Change in Value of Highway Receipts Reflecting Inflation and VMT For Selected Years 1950-1984 (Base Year 1982)



CHAPTER III

HIGHWAY CONDITIONS AND PERFORMANCE

- Total travel in 1983 reached 1.65 trillion VMT, an increase of 6.4 percent over 1981.
- Travel growth in the sunbelt States and California was above the national average. Travel growth in the northeast (except New England) and the mid-west was below the national average.
- In 1983, travel on Federal-aid primary highways (including the Interstate System) accounted for one-half of all highway travel in the country.
- Highway mileage increased by approximately 45,000 miles between 1978 and 1983. Over 75 percent of this increase were lightly traveled local roads.
- Interstate pavement condition has deteriorated since 1978 with most of the change occurring before 1982 and some improvement from 1982 to 1983. Pavement condition on the other major highways has generally remained constant.
- The number of deficient or obsolete bridges increased between 1982 and 1984.
- Highway fatality rates on rural and urban arterials have been fairly stable between 1977 and 1983. Collector roads have experienced considerable change during this period. Rural collectors had the highest fatality rates of all nonlocal roads.
- The percent of peak-period travel occurring under congested conditions between 1978 and 1983 has increased on the Interstate System and other rural arterials. This increase reflects the growth in travel that has taken place following the end of the motor fuel shortages of 1979 and 1980.
- Overall, highway user costs (vehicle operating cost plus traveltime) have increased approximately 1 percent between 1980 and 1983. This increase resulted primarily from changes in pavement condition and increasing congestion brought on by travel growth during the period.

INTRODUCTION

The material in this chapter includes those features of the major highways that affect performance. Included is information about system mileage and travel, travel growth, and the condition of the various systems in terms of pavement, bridges, congestion levels, accidents, etc.

The information has been developed primarily from data supplied by the State transportation agencies via the Highway Performance Monitoring System (HPMS). These data, updated annually by the States, provide the Federal Highway Administration (FHWA) with information about highway physical conditions and usage. Data about pavement, roadway cross-section, alignment, and usage are collected for several panels of sample sections of highway in each State. The HPMS data are the primary sources of information for the Federal Government about the Nation's highway infrastructure.

Another data system used to develop information for this chapter is the national bridge inventory. This inventory is updated continuously by the States, and includes detailed information about all highway bridges in the country. The primary use for this information is to develop an annual report to Congress on bridge needs. The bridge inventory is also cross-referenced with the HPMS.

The material presented in this chapter has, in general, been aggregated to the national level to describe the relative differences between highway systems and changes that are occurring on those systems over time. Most of the data are available at the State level as well. The annual FHWA publication titled Highway Statistics contains information about the physical condition and usage of highways at the individual Stat level.

The latest data presented here on highway physical conditions were collected in 1983 and early 1984 by the State transportation agencies and represent highway conditions that existed on December 31, 1983. Because of the long lead time needed to complete the surveys and process the data, reporting of information is delayed nearly 1 year. Because of this time lag, the information presented in this chapter includes only the initial impact of construction activity following the passage of the Surface Transportation Assistance Act (STAA) of 1982. Even in that short period, however, certain positive trend changes appear to be emerging.

The stratification of information on conditions and travel is generally by functional system at the national level. The classification of highways by function, as described earlier in this report, is consistent among the States and includes the criteria for defining Federal-aid systems as well. The Interstate System, which is a subset of the principal arterial system, is separated because of its national importance. The Federal-aid primary system consists entirely of rural arterials, including Interstate routes, urban Interstate routes, major urban non-Interstate freeways and expressways, and some major urban principal arterials. The Federal-aid secondary system is a subset of the rural major collectors, and the Federal-aid urban system consists primarily of urban minor arterials and collectors.

The information on physical conditions is presented in three major categories. The **condition** of the various systems, the element that is subject to deterioration, includes both pavement and bridge information. The **safety** element of highways includes information on roadway cross-sections and alignment. Finally, the **service** element, which reflects the relative demand for highways, includes information about operating speeds and congestion.

Definitions

Throughout the chapter, certain technical terms appear that may not be familiar to the reader. The following is a list of the most frequently used terms and their definitions.

> Vehicle-Miles-Traveled (VMT) - an aggregate measure of travel taking place on a portion of, or total, highway system. It represents the summation of all miles traveled by all vehicles during a fixed period of time.

Volume - The number of vehicles that pass over a given section of a lane or a roadway during a time period of 1 hour or more.

Average Daily Traffic (ADT) - The total volume during a given time period in whole days greater than 1 day and less than 1 year divided by the number of days in that period.

Capacity - The maximum number of vehicles that has a reasonable expectation of passing over a given section of a lane of a roadway in one direction (or in both directions for a two-lane or three-lane highway) during a given time period under prevailing roadway and traffic conditions.

Volume/Capacity Ratio (V/C) - A factor used in determining congestion levels on a section of highway. It compares the volume using the section to its theoretical capacity, for a particular time period. A V/C ratio of .85 or higher usually indicates unstable traffic flow conditions (congestion).

Present Serviceability Rating (PSR) - An index used to rate the quality of the pavement surface. The rating is based on a visual inspection of the surface compared to an established scale of 5 to 0 where 5 is perfect and O indicates extraordinary pavement deterioration.

Operating Speed - The highest overall speed at which a driver can travel on a given highway under favorable weather conditions and under prevailing traffic conditions without at any time exceeding the safe speed as determined by the design of the section.

MILEAGE AND TRAVEL

Total travel in 1983 was 1.65 trillion VMT, an increase of 6.4 percent over 1981 (see Table III-1 and Figure III-1). Among individual States, California led the Nation in 1983 with 183 billion VMT, or 11.1 percent of all travel (see Tables III-2 and III-3). As Tables III-2 and III-3 show, most of the travel growth since 1978 occurred in the sunbelt States and in the west. With the exception of New England, travel growth in the northeast and midwest regions since 1978 has been at or below the national average.

Table III-4 shows the relationship of Federal-aid system travel to travel on the various functional highway classes. Travel on Federal-aid systems in 1983 equaled 1,327 billion VMT or 80 percent of all highway travel. The primary system, excluding Interstate mileage, accounted for 36 percent of all Federal-aid system travel. When Interstate System travel is included, the primary system accounted for 819,054 million VMT or 62 percent of Federal-aid system travel and 50 percent of all highway travel in the country.

In 1983 there were 3,879,638 miles of public roads and streets in the U.S. (see Table III-5). Although 83 percent of these roads were in rural areas, urban mileage increased since 1978 while rural mileage decreased, primarily due to redefinition of rural to urban areas by the 1980 census. Total highway mileage increased by 44,928 miles or

1.17 percent between 1978 and 1983. Over 75 percent of the increase were additions to lightly traveled local roads that provide access to homes and farms. Only 7,468 miles of non-Interstate, nonlocal roads were constructed during the 1978 through 1983 period.

Table III-6 shows the relationship of Federal-aid system miles to the various functional systems. The Federal-aid systems combined totaled 834,562 miles in 1983. They accounted for 70 percent of nonlocal roads and streets in the U.S. and 22 percent of all public road mileage.

Table III-7 shows the average daily density of travel on roads and streets by functional system. Travel on the Interstate System, on a per mile basis, grew 5 percent between 1978 and 1983, identical to travel on the total nonlocal roads and streets during the same period.

HIGHWAY PERFORMANCE

The purpose of this section is to describe the performance of the various highway systems by measuring a variety of physical and operating characteristics, some of which are relatively fixed, e.g., lane width and alignment, and some of which are subject to rapid change, e.g., pavement condition. Highway performance can be related to a single characteristic or a combination of characteristics. Changes in performance then can be described by comparing the measured characteristics over time.

Data reported by the States have been organized into three broad categories: "condition," "safety," and "service." **Condition** data primarily reflect pavement and bridge conditions. **Safety** data include horizontal and vertical alignment, lane width, shoulder width and shoulder type. **Service** data include peak-period, volume-to-capacity ratios, as a measure of congestion and operating speed.

Condition

Table III-8 contains a summary of pavement condition on the various functional systems for 4 years. The pavement condition is defined by a Present Serviceability Rating (PSR) according to the definitions contained in Figures III-2 and III-3. Column 2 in Table III-8 includes the miles and percent of the system that the States reported as at or beyond the point where resurfacing was needed. Column 3 is included to show how much of the system was at or beyond a point where rapid deterioration could be expected (the mileage in Column 2 is included in Column 3). Column 4 is included to show how much pavement was new or nearly new.

The results of the inventories conducted during the 1978 through 1983 period indicate that the Interstate System experienced the most rapid deterioration but still had the highest percentage of good pavement of all systems. This can be explained, in part, by the fact that much of the Interstate is relatively new mileage, and over 2,800 miles of new pavement were added during the period. At the same time, the concentration of travel, particularly by trucks, accelerated the deterioration of the riding surfaces already in place.

The percentage of Interstate pavement that was at or below a PSR of 2.5 is not distributed evenly throughout the country (see Table III-9 and Figures III-4 and III-5). Although there is no apparent trend for the location of unusually large or small quantities of pavement in need of repair, it is clear that a small number of States have large percentages of Interstate pavement at or below a PSR 2.5. In fact, there were 36 States that were either average or had less than the average percent of poor pavement while six States reported 30 percent or more of their rural Interstate needed repair and seven States reported a similar situation for urban Interstate pavement.

It should be pointed out, however, that the derivation of PSR as a measure of pavement condition is not a rigidly defined process. Rather, it is based on the engineering judgment of individual State highway personnel and norms acceptable within each State.

Detailed information about pavement condition and other physical features related to highway performance at the individual State level, can be found in the annual report Highway Statistics, published by the FHWA.

Figures III-6 and III-7 contain a summary of the results of an analysis to determine how individual sections of highway are changing over time. For this analysis, highway sections that had matching sample identification numbers in the HPMS were selected. In some cases, sample sections changed from rural to urban during the 2 years that were compared and were not included. If a sample section changed functional class, it was included and was reported by its functional class for the first year being used in the comparison.

The figures show that for the years 1980 and 1982, 6.8 percent or 2,067 miles of the expanded sample on the Interstate System deteriorated from a good or fair condition (above 2.5 PSR) to a point where resurfacing or pavement rehabilitation was needed (at or below 2.5 PSR). During the same 2-year period, 3.3 percent or 992 miles of the sample mileage was improved, indicating that Interstate System pavement was wearing out twice as fast as it was being replaced. During the year following the passage of the 1982 STAA, further deterioration of pavement condition of the sample mileage was essentially halted, with 3 percent of the pavement deteriorating and a similar percent being improved. On the other arterials, a similar trend toward reversing pavement deterioration was measured.

Another major highway element that experiences condition deterioration as a result of weather and usage is bridges. Tables III-10 through III-12 contain information on the number of deficient bridges in September 1982 and December 1983. Interstate bridge deficiencies demonstrate the same characteristics as Interstate pavement condition; that is, the 42,500-mile System has the smallest percentage of deficient bridges but the growth in deficient bridges is greatest on the Interstate.

Safety

Certain physical features of a road or street add to overall driving safety. Divided highways with access control eliminate most cross traffic conflicts, provide unlimited passing opportunities and, consequently, have the lowest fatality rates. On undivided facilities, such features as adequate lane and shoulder width and good passing sight distance reduce the potential for accidents.

Figures III-8 and III-9 show the number of fatalities and the fatality rates for the various functional classes. The fatality rates for rural arterials and collectors, although declining, were the highest of any of the major public roads or streets. This was caused, in part, by geometric and roadway cross section deficiencies. Tables III-13 through III-16 contain information about design features of the various rural functional classes that affect safety. The information in Tables III-13 through III-15, related to roadway alignment and cross-section, shows that the rural collector highways had a much greater percentage of travel exposed to roads with narrow, unpaved shoulders, and to highway curves and grades that required reduced speed for safety, than did arterial highways. Although most of these collectors were lightly traveled, the lack of adequate sight distance on these winding, hilly roads was, in part, responsible for the high fatality rates that beset these functional systems.

Another factor that contributes to highway safety is adequate roadway lane width. This is especially true today as both truck traffic and truck size are increasing. Table III-16 shows that practically all rural arterial mileage had lane widths of 10 feet or wider. By contrast, over 6 percent of the rural collector lane widths were less than 9 feet, and not adequate to accommodate the 102 inch widths of todays new trucks.
This information is not displayed for urban roads and streets because their operating speeds are typically controlled by other constraints, e.g., stop signs, traffic lights and speed zones.

Listings of single and multiple highway deficiencies[1] are contained in Table III-17. This table quantifies the various combinations of deficiencies that exist on the major roads and streets. It should be noted that mileage with deficiencies appears in the table only once. For example, if a section of road has pavement condition, geometric, and roadway cross-section deficiencies, it is not included in any other single or multiple deficiency combination.

The rural collector systems, which as functional classes had the highest fatality rates, had a combination of geometric and roadway cross-section deficiencies on 31 percent of the mileage. Overall, 83 percent of the rural collector mileage had at least one deficiency. By contrast, 58 percent of the urban collectors had no deficiencies.

Service

The service element of highway performance is related primarily to operating speed. In urban areas, peak period congestion levels and other traffic delays usually determine how quickly a trip can be made. In rural areas, such features as curves and grades, and, to a lesser extent, capacity determine overall travel speeds. The single and multiple deficiencies listed in Table III-17 shows that operational deficiencies, as a percentage of miles and VMT, were highest on the urban Interstate System. This resulted primarily from the high congestion levels experienced on urban Interstate routes during peak periods.

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[1] A deficiency is defined as a performance element that is at or below a specified minimum level. These minimum levels represent a consensus of technical expertise within the highway engineering discipline. Minimum levels used in this analysis are included in Tables III-18 and 19.

(Figures III-10 and III-11 contain information about miles and VMT exposed to congested highway conditions during peak periods of travel.) In rural areas, 16 percent of the arterials (excluding Interstate) had some operational deficiency, although congestion was generally not a problem on these rural highways.

The service element of highway performance is very sensitive to changes in travel growth rates. Just prior to the 1979 oil crisis, both urban and rural Interstate highways were experiencing congestion on an increasing percentage of miles as Figures III-9 and III-10 indicate. During and immediately after the oil crisis (1979-1981) overall travel and Interstate System traffic congestion both declined, especially in rural areas. As travel growth rates returned to historical levels, congestion on the Interstate System and other rural arterials again increased. Traffic growth, as the following section illustrates, has a significant impact on aggregate highway performance. This is particularly true in the short term since increases in highway capacity take long periods of time to plan, finance and construct.

IMPACT OF CHANGING HIGHWAY CONDITIONS

Changes in pavement and bridge condition, congestion levels, operating speeds, and highway geometrics affect the costs involved in using the Nation's roads and streets. These highway user costs, both private and commercial, eventually impact the national economy through transportation costs for goods and services. This section discusses the changes in highway user costs over time as an indicator of composite changes in highway performance.

The HPMS analytical procedure produces the following statistics describing highway conditions for both the existing and forecast years. (The Appendix contains a more detailed description of the methodology used in this analysis.)

1. Operating cost per 1000 VMT (by functional class and vehicle type).
2. The rates of total accidents, fatal accidents, and nonfatal injury accidents (per 100 million VMT; by functional class).
3. Average travel speeds (by functional class and vehicle type).

Each of these statistics represents a separate component of the total economic cost of highway travel. Since the data are expressed in different units (dollars/1000 VMT, accidents/100 million VMT, and miles/hour) they cannot readily be combined into a single measure of overall highway performance. A single measure is useful for comparing the relative costs of a given investment level with the resultant benefits from that investment.

It is important to recognize the very subjective nature of assigning monetary costs to the tragedy of accidental injury or death, or to the lost opportunity of spent time. Calculations of the value of time are rightfully debatable, and must always be considered imprecise. More importantly, the personal loss and suffering that result from accidental injury or death simply cannot be measured. As a result, the cost estimates used in this analysis are explicitly limited to the economic costs that are borne by society.

Figure III-12 describes how unit costs for highway travel changed between 1980 and 1983. During this period, the total cost per VMT increased 1.3 percent from

$481.21 per 1,000 VMT to $487.39 per 1,000 VMT. The major increases occurred on the Interstate System and rural arterials. Collector routes in rural areas increased slightly while nonfreeway type arterials and collectors in urban areas experienced small declines in unit user costs.

The overall increase in unit travel costs reflects the general deterioration in pavement conditions and increased congestion levels caused by travel growth since 1981. As the information in Table III-8 shows, urban and rural Interstate pavement condition deteriorated significantly between 1981 and 1983 and congestion increased, particularly on rural arterials (see Figure III-10). Overall, user costs increased $68.98 billion, from $636.39 billion to $705.37 billion during the 3-year period. Much of this increase, however, was a result of increased travel rather than increases in the unit cost of travel.

Table III-1
Highway Travel Comparison (1978-1983)
(Travel in Millions of VMT)

Rural Summary	1978 Travel	1978-1981 Percent Change	1981 Travel	1981-1983 Percent Change	1983 Travel	1978-1983 Percent Change
Principal Arterial						
Interstate	139,673	-0.9	138,395	4.6	144,733	3.6
Other	138,090	-1.9	135,463	3.3	139,962	1.4
Minor Arterial	132,340	0.1	132,407	0.8	133,421	0.8
Collector						
Major	149,984	2.8	154,254	1.6	156,786	4.5
Minor	38,748	6.7	41,331	6.0	43,806	13.1
Rural Subtotal	598,835	0.5	601,850	2.8	618,708	3.3
Local Roads	87,859	-3.2	85,049	-3.8	81,825	-6.9
RURAL TOTAL	686,694	0.0	686,899	2.0	700,533	2.0

Urban Summary	1978 Travel	1978-1981 Percent Change	1981 Travel	1981-1983 Percent Change	1983 Travel	1978-1983 Percent Change
Principal Arterial						
Interstate	163,268	2.2	166,817	14.6	191,149	17.1
Other Freeway and Expressway	86,026	-4.6	82,051	5.8	86,790	0.9
Other Principal Arterials	245,025	-4.4	234,309	9.0	255,327	4.2
Minor Arterials	175,291	-1.3	173,088	8.9	188,467	7.5
Collectors	82,538	-1.0	81,705	6.0	86,593	4.9
Urban Subtotal	752,148	-1.9	737,970	9.5	808,326	7.5
Local Roads	125,745	-0.3	125,402	11.8	140,247	11.5
URBAN TOTAL	877,893	-1.7	863,372	9.9	948,573	8.1
TOTAL	1,564,587	-0.9	1,550,271	6.4	1,649,106	5.4

Table III-2
Annual Travel by State
(VMT in Millions)

	1978 VMT	1978-1981 Percent Change	1981 VMT	1981-1983 Percent Change	1983 VMT	1978-1983 Percent Change
Alabama	29,907	-6.9	27,852	11.4	31,032	3.8
Alaska	2,760	5.5	2,911	15.4	3,358	21.7
Arizona	19,364	-4.1	18,570	5.6	19,611	1.3
Arkansas	16,424	2.1	16,770	-0.5	16,684	1.6
California	162,389	-1.5	159,900	14.2	182,652	12.5
Colorado	21,252	5.1	22,337	7.9	24,109	13.4
Connecticut	18,888	2.5	19,366	6.5	20,630	9.2
Delaware	4,232	5.3	4,458	9.6	4,886	15.5
District of Columbia	3,549	-6.8	3,308	-6.3	3,099	-12.7
Florida	71,765	6.1	76,145	7.4	81,776	13.9
Georgia	44,307	1.2	44,843	8.9	48,837	10.2
Hawaii	4,738	23.6	5,855	0.3	5,873	23.9
Idaho	7,689	-9.3	6,977	18.8	8,287	7.8
Illinois	65,827	0.0	65,836	2.3	67,370	2.3
Indiana	41,888	-7.2	38,882	2.5	39,837	-4.9
Iowa	19,802	-3.5	19,113	2.9	19,661	-0.7
Kansas	17,088	2.2	17,470	3.9	18,153	6.2
Kentucky	27,607	-8.7	25,195	6.0	26,719	-3.2
Louisiana	23,685	5.4	24,960	10.5	27,573	16.4
Maine	7,972	-4.8	7,587	4.4	7,924	-0.6
Maryland	25,323	13.0	28,617	7.0	30,618	20.9
Massachusetts	35,052	2.6	35,948	4.4	37,541	7.1
Michigan	77,012	-19.4	62,090	-2.0	60,855	-21.0
Minnesota	28,791	-0.4	28,678	8.3	31,063	7.9
Mississippi	17,281	-1.9	16,952	5.0	17,802	3.0
Missouri	34,667	1.5	35,178	3.9	36,543	5.4
Montana	7,021	-0.3	7,002	2.6	7,181	2.3
Nebraska	12,694	-9.4	11,504	0.3	11,534	-9.1
Nevada	5,750	13.3	6,515	5.5	6,872	19.5
New Hampshire	4,413	48.9	6,570	9.3	7,181	62.7
New Jersey	52,465	-2.2	51,328	1.7	52,217	-0.5
New Mexico	11,507	-0.3	11,470	1.8	11,678	1.5
New York	75,375	5.0	79,130	5.9	83,783	11.2
North Carolina	43,580	-3.5	42,059	7.1	45,083	3.3
North Dakota	5,287	1.2	5,352	0.2	5,363	1.4
Ohio	73,140	-1.9	71,728	2.1	73,214	0.1
Oklahoma	26,763	7.5	28,780	2.7	29,565	10.5
Oregon	19,837	-1.6	19,516	5.3	20,557	3.6
Pennsylvania	72,709	-1.7	71,508	1.1	72,302	-0.6
Rhode Island	5,742	-2.9	5,575	7.9	6,014	4.7
South Carolina	24,254	-5.0	23,054	8.3	24,977	3.0
South Dakota	5,831	3.4	6,029	4.8	6,317	8.3
Tennessee	38,084	-8.8	34,729	4.4	36,261	-4.8
Texas	109,351	9.8	120,084	9.8	131,883	20.6
Utah	9,827	9.2	10,732	4.6	11,221	14.2
Vermont	3,772	1.7	3,835	8.2	4,151	10.0
Virginia	40,542	-5.2	38,432	10.1	42,299	4.3
Washington	28,855	4.9	30,268	19.4	36,144	25.3
West Virginia	11,894	-12.2	10,440	12.0	11,696	-1.7
Wisconsin	33,864	-0.7	33,611	1.5	34,106	0.7
Wyoming	4,630	12.8	5,222	-3.1	5,059	9.3
National	1,561,819	-0.7	1,550,271	6.4	1,649,106	5.6

Table III-3
Annual Travel by Region*
(VMT in Millions)

	1978 VMT	1978-1981 Percent Change	1981 VMT	1981-1983 Percent Change	1983 VMT	1978-1983 Percent Change
New England						
Connecticut	18,888	2.53	19,366	6.53	20,630	9.22
Maine	7,972	-4.83	7,587	4.44	7,924	-0.60
Massachusetts	35,052	2.56	35,948	4.43	37,541	7.10
New Hampshire	4,413	48.88	6,570	9.30	7,181	62.73
Rhode Island	5,742	-2.91	5,575	7.87	6,014	4.74
Vermont	3,772	1.66	3,835	8.24	4,151	10.04
Total	75,839	4.01	78,881	5.78	83,441	10.02
Mideast						
Delaware	4,232	5.34	4,458	9.60	4,886	15.46
District of Columbia	3,549	-6.79	3,308	-6.32	3,099	-12.68
Maryland	25,323	13.01	28,617	6.99	30,618	20.91
New Jersey	52,465	-2.17	51,328	1.73	52,217	-0.47
New York	75,375	4.98	79,130	5.88	83,783	11.15
Pennsylvania	72,709	-1.65	71,508	1.11	72,302	-0.56
Total	233,653	2.01	238,349	3.59	246,905	5.67
Northern Southeast						
Kentucky	27,607	-8.74	25,195	6.05	26,719	-3.22
North Carolina	43,580	-3.49	42,059	7.08	45,038	3.34
South Carolina	24,254	-4.95	23,054	8.34	24,977	2.98
Tennesse	38,084	-8.81	34,729	4.41	36,261	-4.79
Virginia	40,542	-5.20	38,432	10.06	42,299	4.33
West Virginia	11,894	-12.22	10,440	12.03	11,696	-1.66
Total	185,961	-6.48	173,909	7.52	186,990	0.55
Southern Southeast						
Alabama	29,907	-6.87	27,852	11.42	31,032	3.76
Arkansas	16,424	2.10	16,770	-0.51	16,684	1.58
Florida	71,765	6.10	76,145	7.40	81,776	13.95
Georgia	44,307	1.21	44,843	8.91	48,837	10.22
Louisiana	23,685	5.38	24,960	10.47	27,573	16.41
Mississippi	17,281	-1.90	16,952	5.01	17,802	3.02
Total	203,369	2.04	207,522	7.80	223,704	10.00
Great Lakes						
Illinois	65,827	0.01	65,836	2.33	67,370	2.34
Indiana	41,888	-7.18	38,882	2.46	39,837	-4.90
Michigan	77,012	-19.38	62,090	-1.99	60,855	-20.98
Ohio	73,140	-1.93	71,728	2.07	73,214	0.10
Wisconsin	33,864	-0.75	33,611	1.47	34,106	0.72
Total	291,731	-6.71	272,147	1.19	275,382	-5.60

Table III-3 (continued)

	1978 VMT	1978-1981 Percent Change	1981 VMT	1981-1983 Percent Change	1983 VMT	1978-1983 Percent Change
Plains						
Iowa	19,802	-3.48	19,113	2.87	19,661	-0.71
Kansas	17,088	2.23	17,470	3.91	18,153	6.23
Minnesota	28,791	-0.39	28,678	8.32	31,063	7.89
Missouri	34,667	1.47	35,178	3.88	36,543	5.41
Nebraksa	12,694	-9.37	11,504	0.26	11,534	-9.14
North Dakota	5,287	1.22	5,352	0.21	5,363	1.43
South Dakota	5,831	3.40	6,029	4.78	6,317	8.34
Total	124,161	-0.67	123,324	4.31	128,634	3.60
Southwest						
Arizona	19,364	-4.10	18,570	5.61	19,611	1.28
New Mexico	11,507	-0.32	11,470	1.81	11,678	1.49
Oklahoma	26,763	7.54	28,780	2.73	29,565	10.47
Texas	109,351	9.82	120,084	9.83	131,883	20.61
Total	166,984	7.14	178,904	7.73	192,737	15.42
Rocky Mountain						
Colorado	21,252	5.11	22,337	7.93	24,109	13.44
Idaho	7,689	-9.26	6,977	18.78	8,287	7.78
Montana	7,021	-0.27	7,002	2.56	7,181	2.28
Utah	9,827	9.21	10,732	4.56	11,221	14.18
Wyoming	4,639	12.79	5,222	-3.12	5,059	9.27
Total	50,419	3.67	52,270	6.86	55,857	10.79
Far West						
California	162,389	-1.53	159,900	14.23	182,652	12.48
Nevada	5,750	13.31	6,515	5.48	6,872	19.52
Oregon	19,837	-1.62	19,516	5.33	20,557	3.63
Washington	28,855	4.90	30,268	19.41	36,144	25.26
Total	216,832	-0.29	216,199	13.89	246,225	13.56
Pacific						
Alaska	2,760	5.47	2,911	15.36	3,358	21.66
Hawaii	4,738	23.56	5,855	0.31	5,873	23.94
Total	7,499	16.90	8,766	5.30	9,231	23.10
NATIONAL TOTAL	1,561,819	-.74	1,550,271	6.30	1,649,106	5.59

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*Bureau of Economic Analysis regions.

Table III-4

1983 Travel on Federal-aid System
(In milllions of VMT)

Functional Class	Federal-Aid Primary		Federal-Aid Secondary		Federal-Aid Urban	
	Rural	Urban	Rural	Urban	Rural	Urban
Interstate	144,733	191,149	0	0	0	0
Other Freeways and Expressways	0	81,043	0	0	0	8,774
Other Principal Arterials	136,338*	126,098*	0	0	0	119,147
Minor Arterials	133,374*	6,319*	0	0	0	164,717
Major Collectors	0	0	148,250	0	0	0
Minor Collectors	0	0	0	0	0	0
Collectors	0	0	0	0	0	67,379
Non-Interstate Total	269,712	213,460	148,250	0	0	360,017
Total	414,445	404,609	148,250	0	0	360,017

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*Estimated.

Table III-5
Highway Mileage Comparison (1978-1983)

Rural Summary	1978 Miles	1978-1981 Percent Change	1981 Miles	1981-1983 Percent Change	1983 Miles	1978-1983 Percent Change
Principal Arterial						
Interstate	31,477	4.71	32,959	-0.52	32,788	4.16
Other	82,412	-0.92	81,655	0.52	81,234	-1.43
Minor Arterial	149,684	-0.57	148,826	-0.87	147,536	-1.44
Collector						
Major	432,895	1.74	440,409	-1.42	434,166	0.29
Minor	301,783	-0.75	299,515	0.22	300,172	-0.53
Rural Subtotal	998,251	0.51	1,003,364	-0.74	995,896	-0.24
Local Roads	2,232,950	-0.70	2,217,320	0.18	2,221,392	-0.52
RURAL TOTAL	3,231,201	-0.33	3,220,684	-0.11	3,217,288	-0.43

Urban Summary	1978 Miles	1978-1981 Percent Change	1981 Miles	1981-1983 Percent Change	1983 Miles	1978-1983 Percent Change
Principal Arterial						
Interstate	9,353	-0.47	9,309	10.00	10,240	9.48
Other Freeway and Expressway	6,522	4.29	6,802	3.26	7,024	7.70
Other Principal Arterials	45,819	-2.03	44,889	5.44	47,330	3.30
Minor Arterials	65,218	1.33	66,086	4.57	69,108	5.96
Collectors	67,292	2.70	69,109	4.93	72,513	7.76
Urban Subtotal	194,204	1.03	196,195	5.11	206,215	6.18
Local Roads	409,305	6.48	435,818	4.66	456,135	11.44
URBAN TOTAL	603,509	4.72	632,013	4.80	662,350	9.75
TOTAL	3,834,710	0.47	3,852,697	0.70	3,879,638	1.17

Table III-6
1983 Mileage on Federal-aid System

Functional Class	Federal-Aid Primary		Federal-Aid Secondary		Federal-Aid Urban	
	Rural	Urban	Rural	Urban	Rural	Urban
Interstate	32,788	10,240	0	0	0	0
Other Freeways and Expressways	0	5,897	0	0	0	723
Other Principal Arterials	80,387	23,350	0	0	0	22,864
Minor Arterials	145,541	1,837	0	0	0	60,373
Major Collectors	0	0	397,329	0	0	0
Minor Collectors	0	0	0	0	0	0
Collectors	0	0	0	0	0	53,233
Non-Interstate Total	225,928	31,084	397,329	0	0	137,193
Total	258,716	41,324	397,329	0	0	137,193

Table III-7
Daily Travel Per Mile
(Thousands of VMT Per Mile)

Rural Summary	1978	1981	1983
Principal Arterial			
Interstate	12.16	11.50	12.09
Other	4.59	4.55	4.72
Minor Arterial	2.42	2.44	2.48
Collector			
Major	0.95	0.96	0.99
Minor	0.35	0.38	0.40
Rural Subtotal	1.64	1.64	1.70
Local Roads	0.11	0.11	0.10
RURAL TOTAL	0.58	0.58	0.60

Urban Summary	1978	1981	1983
Principal Arterial			
Interstate	47.83	49.10	51.14
Other Freeway and Expressway	36.14	33.05	33.85
Other Principal Arterials	14.65	14.30	14.78
Minor Arterials	7.36	7.18	7.47
Collectors	3.36	3.24	3.27
Urban Subtotal	10.61	10.31	10.74
Local Roads	0.84	0.79	0.84
URBAN TOTAL	3.99	3.74	3.92
TOTAL	1.12	1.10	1.16

Table III-8
Estimated Miles of Highway by Pavement Condition[1] and Year

Functional System and Year	1 Total Miles	2 Less than or Equal to 2.0 PSR[2] Miles	 Percent	3[3] Less than or Equal to 3.0 PSR Miles	 Percent	4 Greater than or Equal to 4.0 PSR Miles	 Percent
Interstate - Rural							
1978	31,161	3,116	10.0	7,603	24.4	13,339	43.0
1981	32,959	2,966	9.0	7,515	22.8	12,426	37.7
1982	32,879	4,439	13.5	8,713	26.5	10,061	30.6
1983	32,788	4,295	13.1	8,558	26.1	10,427	31.8
Interstate - Urban							
1978	9,048	986	10.9	2,461	27.2	3,420	37.8
1981	9,309	931	10.0	2,355	25.3	3,202	39.2
1982	9,581	1,562	16.3	2,884	30.1	3,296	34.4
1983	10,240	1,792	17.5	3,471	33.9	3,082	30.1
Other Arterials - Rural							
1978	232,096	23,906	10.3	112,799	48.6	56,167	24.2
1981	[illegible],481	26,044	11.3	98,415	42.7	52,550	22.8
1982	229,897	30,346	13.2	104,143	45.3	46,899	20.4
1983	228,770	24,250	10.6	99,774	43.6	45,983	20.1
Other Arterials - Urban							
1978	117,559	11,521	9.8	59,838	50.9	25,275	21.5
1981	117,777	12,131	10.3	52,883	44.9	27,443	23.3
1982	119,789	12,578	10.5	56,780	47.4	28,270	23.6
1983	123,462	12,470	10.1	60,003	48.6	26,668	21.6
Collectors - Rural							
1978	734,678	130,038	17.7	479,745	65.3	80,815	11.0
1981	739,924	142,065	19.2	436,856	58.5	108,769	14.7
1982	738,524	135,150	18.3	417,266	56.5	113,733	15.4
1983	734,338	126,306	17.2	417,838	56.9	111,619	15.2
Collectors - Urban							
1978	67,292	12,381	18.4	44,816	66.6	7,940	11.8
1981	69,109	8,915	12.9	36,835	53.3	12,509	18.1
1982	69,562	10,088	14.5	38,889	55.9	12,383	17.8
1983	72,513	11,530	15.9	42,130	58.1	11,675	16.1

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[1] Condition is measured by Present Serviceability Rating (PSR) - 2.0 (2.5 for Interstate) marks the point between pavement in fair condition and poor condition - 3.0 is the point where rapid deterioration can be expected - 4.0 and above identifies new or nearly new pavement. (See page 73 for more detailed description.)

[2] 2.5 for Interstate.

[3] Miles in this column include miles in Column II.

Table III-9
Deficient Interstate Pavement by States
1983 Interstate Mileage with PSR Less Than or Equal to 2.5

	RURAL			URBAN		
	Total Miles	Deficient Miles	Deficient Percent	Total Miles	Deficient Miles	Deficient Percent
Alabama	633.7	0.0	0.0	191.0	0.0	0.0
Alaska	1,071.9	338.0	31.5	20.4	6.9	33.8
Arizona	1,016.9	46.5	4.6	123.0	18.1	14.7
Arkansas	419.3	9.2	2.2	122.0	8.0	6.6
California	1,444.7	173.2	12.0	937.1	140.2	15.0
Colorado	788.0	97.8	12.4	158.0	18.9	12.0
Connecticut	107.6	0.0	0.0	229.3	0.7	0.3
Delaware	0.0	0.0	0.0	40.9	0.0	0.0
District of Columbia	0.0	0.0	0.0	12.0	2.2	18.1
Florida	926.8	64.8	7.0	323.7	0.2	0.0
Georgia	886.6	9.7	1.1	291.5	2.5	0.9
Hawaii	5.4	0.0	0.0	30.6	0.0	0.0
Idaho	537.2	67.1	12.5	71.3	6.5	9.1
Illinois	1,255.0	32.6	2.6	456.0	86.1	18.9
Indiana	854.6	42.6	5.0	260.7	10.0	3.8
Iowa	613.8	1.8	0.3	122.4	0.0	0.0
Kansas	654.8	409.6	62.6	153.8	127.8	83.1
Kentucky	579.4	40.0	6.9	158.5	16.9	10.7
Louisiana	519.0	35.3	6.8	172.8	11.3	6.6
Maine	277.0	10.0	3.6	36.8	4.9	13.4
Maryland	191.0	44.4	23.2	186.0	18.4	9.9
Massachusetts	172.0	6.4	3.7	390.0	0.7	0.2
Michigan	714.7	477.7	66.8	416.1	340.1	81.7
Minnesota	696.8	16.2	2.3	177.1	8.9	5.0
Mississippi	558.1	104.2	18.7	116.7	34.5	29.6
Missouri	823.5	81.3	9.9	308.6	154.9	50.2
Montana	1,090.0	33.5	3.1	46.5	1.4	3.1
Nebraska	444.2	0.0	0.0	37.7	3.2	8.4
Nevada	501.8	50.2	10.0	36.0	0.0	0.0
New Hampshire	163.7	2.7	1.6	44.7	0.0	0.0
New Jersey	128.0	1.2	0.9	253.6	14.1	5.6
New Mexico	912.8	327.2	35.8	86.8	19.6	22.6
New York	881.2	45.0	5.1	607.4	82.9	13.6
North Carolina	578.0	15.4	2.7	183.3	15.8	8.6
North Dakota	533.7	0.0	0.0	37.7	0.0	0.0
Ohio	880.0	195.2	22.2	664.3	137.0	20.6
Oklahoma	749.0	187.2	25.0	176.4	32.3	18.3
Oregon	584.5	276.2	47.2	133.8	56.6	42.3
Pennsylvania	1,184.9	120.3	10.2	329.3	43.6	13.3
Rhode Island	21.0	12.4	59.3	44.0	17.2	39.1
South Carolina	646.6	20.6	3.2	101.6	3.6	3.6
South Dakota	636.0	0.0	0.0	42.2	0.0	0.0
Tennessee	826.4	110.2	13.3	204.9	0.7	0.3
Texas	2,263.1	334.3	14.8	848.0	199.6	14.1
Utah	679.4	23.3	3.4	124.7	0.0	0.0
Vermont	301.5	4.8	1.6	18.0	0.0	0.0
Virginia	797.7	77.8	9.7	220.2	13.0	5.9
Washington	483.2	111.1	23.0	230.4	21.5	9.3
West Virginia	401.9	51.7	12.9	89.8	10.7	11.9
Wisconsin	466.2	131.4	28.2	111.4	46.8	42.0
Wyoming	866.7	37.6	4.3	48.9	12.9	26.5

Table III-10
Deficient Interstate Bridges

RURAL INTERSTATE BRIDGES

	1982		1984*		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	809	3.1	1,001	3.7	192	0.6
Functionally Obsolete	1,596	6.1	1,879	6.9	283	0.8
Total Deficient Bridges	2,405	9.1	2,880	10.6	475	1.5
TOTAL BRIDGES	26,474		27,261		787	

URBAN INTERSTATE BRIDGES

	1982		1984*		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	1,048	5.3	1,426	6.9	378	1.6
Functionally Obsolete	1,470	7.4	1,970	9.5	500	2.1
Total Deficient Bridges	2,518	12.7	3,396	16.4	878	3.7
TOTAL BRIDGES	19,903		20,766		863	

TOTAL INTERSTATE BRIDGES

	1982		1984*		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	1,857	4.0	2,427	5.1	570	1.1
Functionally Obsolete	3,066	6.6	3,849	8.0	783	1.4
Total Deficient Bridges	4,923	10.6	6,276	13.1	1,353	2.5
TOTAL BRIDGES	46,377		48,027		1,650	

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* As of March 8, 1984.

NOTE: A bridge both structurally deficient and functionally obsolete is classified and counted only as structurally deficient.

Table III-11
Deficient Arterial Bridges

RURAL ARTERIAL* BRIDGES

	1982		1984**		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	6,931	9.3	7,680	10.3	749	1.0
Functionally Obsolete	12,157	16.4	12,117	16.3	-40	-0.1
Total Deficient Bridges	19,088	25.7	19,797	26.6	709	0.9
TOTAL BRIDGES	74,327		74,323		-4	

URBAN ARTERIAL* BRIDGES

	1982		1984**		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	4,772	11.4	5,583	12.5	811	1.1
Functionally Obsolete	6,149	14.7	7,290	16.3	1,141	1.6
Total Deficient Bridges	10,921	26.1	12,873	28.8	1,952	2.7
TOTAL BRIDGES	41,843		44,627		2,784	

TOTAL ARTERIAL* BRIDGES

	1982		1984**		CHANGE	
	Number	Cumulative Percent	Number	Cumulative Percent	Number	Percent
Structurally Deficient	11,703	10.1	13,263	11.2	1,560	1.1
Functionally Obsolete	18,306	15.7	19,407	16.3	1,101	0.6
Total Deficient Bridges	30,009	25.8	32,670	27.5	2,661	1.7
TOTAL BRIDGES	116,170		118,950		2,780	

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* Except Interstate.

** As of March 8, 1984.

NOTE: A bridge both structurally deficient and functionally obsolete is classified and counted only as structurally deficient.

Table III-12
Deficient Collector Bridges

RURAL COLLECTORS BRIDGES

	1982		1984*		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	23,130	16.3	24,703	17.4	1,573	1.1
Functionally Obsolete	31,209	22.1	31,223	22.0	14	-0.1
Total Deficient Bridges	54,339	38.4	55,926	39.4	1,587	1.0
TOTAL BRIDGES	141,503		141,804		301	

URBAN COLLECTORS BRIDGES

	1982		1984*		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	1,663	16.5	1,812	17.0	149	0.5
Functionally Obsolete	1,648	16.4	2,036	19.0	388	2.6
Total Deficient Bridges	3,311	32.9	3,848	36.0	537	3.1
TOTAL BRIDGES	10,075		10,691		616	

TOTAL COLLECTORS BRIDGES

	1982		1984*		CHANGE	
	Number	Percent	Number	Percent	Number	Percent
Structurally Deficient	24,793	16.3	26,515	17.4	1,722	1.1
Functionally Obsolete	32,857	21.7	33,259	21.8	402	0.1
Total Deficient Bridges	57,650	38.0	59,774	39.2	2,124	1.2
TOTAL BRIDGES	151,578		152,495		917	

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* As of March 8, 1984.

NOTE: A bridge both structurally deficient and functionally obsolete is classified and counted only as structurally deficient.

Table III-13
1983 Shoulder Width by Functional Class

	Rural Interstate		Rural Arterials		Rural Collectors	
Right Shoulder Width	Miles	Percent Miles	Miles	Percent Miles	Miles	Percent Miles
0	0	0.00	4	0.00	0	0.00
1-2	386	1.28	19,556	9.93	211,463	37.35
3-4	226	0.75	43,035	21.85	194,318	34.32
5-6	403	1.34	37,883	19.24	98,390	17.38
7-8	951	3.15	44,834	22.77	40,983	7.24
9-10	25,289	83.78	46,573	23.65	18,316	3.23
10 +	2,929	9.70	5,042	2.56	2,761	0.49
Total	30,184	100.0	196,927	100.00	566,231	100.00

	Rural Interstate		Rural Arterials		Rural Collectors	
Left Shoulder Width	Miles	Percent Miles	Miles	Percent Miles	Miles	Percent Miles
0	1,479	4.90	5,509	27.06	768	35.20
1-2	1,355	4.49	2,057	10.10	84	3.85
3-4	17,872	59.21	6,781	33.31	444	20.35
5-6	6,297	20.86	3,826	18.79	693	31.76
7-8	1,810	6.00	1,154	5.67	29	1.33
9-10	1,054	3.49	875	4.30	159	7.29
10 +	317	1.05	159	0.78	5	0.23
Total	30,184	100.00	20,360	100.00	2,182	100.00

Table III-14
Vertical Alignment Adequacy
Rural Functional Systems
(Estimated Percent)

Vertical Alignment Adequacy	Interstate		Other Principal Arterials		Minor Arterials		Major Collectors		Minor Collectors		Total	
	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel
Code 1	92.4	92.7	66.8	73.3	56.5	62.1	45.5	52.6	41.9	47.5	50.6	68.5
Code 2	7.1	6.9	27.1	21.9	33.1	28.4	29.4	27.7	35.8	31.8	30.5	22.0
Code 3	0.5	0.4	3.6	2.8	5.8	5.2	17.3	14.3	13.4	12.0	12.3	6.2
Code 4	0	0	2.5	2.0	4.6	4.2	7.8	5.4	8.9	8.7	6.6	3.3

Code 1: All grades (rate and length) and vertical curves meet minimum design standards appropriate for the terrain. Reduction in rate of length of grade would be unnecessary even if reconstruction were required to meet other deficiencies.

Code 2: Although some grades (rate and/or length) and vertical curves are below appropriate design standards for new construction, all grades and vertical curves provide sufficient sight distance for safe travel and do not substantially affect the speed of trucks.

Code 3: Infrequent grades and vertical curves that impair sight distance and/or affect the speed of trucks if truck climbing lanes are not provided.

Code 4: Frequent grades and vertical curves that impair sight distance and/or severely affect the speed of trucks and truck climbing lanes are not provided.

Sections for which no alignment data is coded are treated as Code 2.

Unpaved sections were not included in this analysis.

Table III-15
Horizontal Alignment Adequacy
Rural Functional Systems
(Estimated Percent)

Horizontal Alignment Adequacy	Interstate		Other Principal Arterials		Minor Arterials		Major Collectors		Minor Collectors		Total	
	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel
Code 1	95.1	95.2	77.6	80.2	70.2	70.8	51.1	56.1	42.5	44.5	57.0	73.3
Code 2	4.1	4.2	14.7	13.5	11.8	13.5	22.5	22.7	23.7	22.9	19.3	14.3
Code 3	0.6	0.4	4.7	4.0	9.2	8.8	15.8	13.3	20.2	21.3	13.9	7.6
Code 4	0.2	0.2	3.0	2.3	8.7	6.9	10.6	7.9	13.6	11.3	9.8	4.8

Code 1: All curves meet appropriate design standards. Reduction of curvature would be unnecessary even if reconstruction was required to meet other deficiencies, i.e., (capacity, vertical alignment, etc.).

Code 2: Although some curves are below appropriate design standards for new construction, all curves can be safely and comfortably negotiated at the prevailing speed limit on the section. The speed limit was not established by design speed of curves.

Code 3: Infrequent curves with design speeds less than the prevailing speed limit on the section. Infrequent curves may have reduced speed limits for safety purposes.

Code 4: General curves uncomfortable and/or unsafe when traveled at the prevailing speed limit in the section, or speed limit on section is severely restricted due to design speed of curves.

Sections for which no alignment data is coded are treated as Code 2.

Unpaved sections were not included in this analysis.

Table III-16
1983 Percent Rural Mileage and Travel by Lane Width[1/]

Lane Width	Interstate		Other Principal Arterials		Minor Arterials		Major Collectors		Minor Collectors		Total	
	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel	Miles	Travel
Greater than 11	100.0	100.0	81.2	84.6	57.4	59.6	26.5	40.1	13.6	16.7	37.5	67.2
11	0	0	13.3	11.3	20.4	22.1	19.8	19.8	13.0	15.1	16.9	13.5
10	0	0	5.0	3.6	17.6	15.2	36.7	27.9	34.4	38.1	28.1	13.6
9	0	0	0.4	0.2	4.4	3.0	13.9	11.0	26.3	21.6	13.1	4.8
Less than 9	0	0	0.1	0.2	0.2	0.1	3.1	1.2	12.7	8.5	4.3	0.9

[1/] Unpaved sections were not included in this analysis.

Table III-17
1983 Multiple Deficiencies
Percent of Miles and DVMT

RURAL											URBAN					
Interstate Deficiencies		Arterials Deficiencies		Collectors Deficiencies		Type of Deficiency					Interstate Deficiencies		Arterials Deficiencies		Collectors Deficiencies	
Miles Percent	Daily VMT Percent	Miles Percent	Daily VMT Percent	Miles Percent	Daily VMT Percent	Pave. Cond.	Geom.*	Road X-Sec.	Oper-ation	Cont. Access	Miles Percent	Daily VMT Percent	Miles Percent	Daily VMT Percent	Miles Percent	Daily VMT Percent
24.4	21.4	7.7	9.3	2.9	3.5	XXX					22.5	16.1	12.1	12.6	5.1	4.6
0.7	0.5	3.6	2.2	5.8	6.7		XXX				---	---	---	---	---	---
2.8	2.3	25.3	17.5	31.6	27.9			XXX			3.4	3.3	15.5	7.5	28.7	20.5
3.5	8.3	2.4	6.5	0.7	2.4				XXX		11.0	20.0	8.6	17.1	3.0	10.4
---	---	---	---	---	---					XXX	---	---	---	---	---	---
0.2	0.1	1.5	1.1	2.0	1.7	XXX	XXX				---	---	---	---	---	---
0.1	0.2	3.0	1.7	8.8	5.5	XXX	XXX	XXX			---	---	---	---	---	---
0.1	0.0	1.9	2.7	0.6	0.7	XXX	XXX	XXX	XXX		---	---	---	---	---	---
0.8	0.6	1.9	9.6	6.7	5.0	XXX		XXX			2.7	2.6	3.9	2.1	4.0	2.2
---	---	---	---	---	---				XXX	XXX	---	---	0.1	0.4	---	---
0.1	0.1	6.6	3.1	21.2	16.1		XXX	XXX			---	---	---	---	---	---
0.2	0.4	4.5	9.0	0.9	1.0			XXX	XXX		1.2	1.9	1.9	2.3	0.9	2.3
---	---	---	---	---	---			XXX	XXX	XXX	---	---	0.1	0.2	---	---
2.2	5.5	1.3	3.4	0.2	0.5	XXX			XXX		9.7	19.5	2.8	6.1	0.4	1.1
0.0	0.1	0.3	0.5	0.1	0.1	XXX	XXX		XXX		---	---	---	---	---	---
0.0	0.0	2.8	5.4	0.5	0.4	XXX		XXX	XXX		1.7	3.5	0.8	1.5	0.1	0.3
---	---	2.1	3.1	0.9	0.6		XXX	XXX	XXX		---	---	---	---	---	---
0.0	0.0	0.5	1.0	0.2	0.8		XXX		XXX		---	---	---	---	---	---
---	---	---	---	---	---	Remaining combination of the above					---	---	0.2	0.3	---	---
64.8	60.4	24.5	23.9	16.9	27.0	Not included above					47.8	33.1	54.0	50.0	57.8	58.6

---

* Geometric deficiency is rural only.

--- Analysis includes paved sections only.

Operation deficiency--operating speed for urban includes Interstate and other freeways and expressways only; for rural includes all functional systems--collectors rural type development only.

Control of access deficiency--Interstate and other freeways and expressways only.

Table III-18
1983 HPMS Deficiency Analysis
Rural Minimum Tolerable Condition Table

Highway Charteristic	INTERSTATE			PRINCIPAL ARTERIALS						MINOR ARTERIALS						MAJOR AND MINOR ARTERIALS								
	All Average Daily Traffic (ADT)			ADT 6000 +			ADT Less than 6000			ADT 2000 +			ADT Less than 2000			ADT 800 +			ADT 250 - 800			ADT Less than 250		
Terrain 1/	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M	F	R	M
Lane Width (ft.)	12	12	12	11	11	11	11	11	11	10	10	10	10	10	10	10	10	10	8	8	8	16 2/	16 2/	16 2/
Right Shoulder Width (ft.)	8	8	6	8	8	6	8	8	6	6	6	4	6	6	4	4	4	4	2	2	2	0	0	0
Shoulder Type 3/	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
Pavement Condition	3.0	3.0	3.0	3.0	3.0	3.0	2.8	2.8	2.8	2.4	2.4	2.4	2.4	2.4	2.4	2.0	2.0	2.0	2.0	2.0	2.0	1.8	1.8	1.8
Operating Speed 4/	50	45	40	50	45	35	45	40	35	40	35	30	30	30	25	30	25	20	---	---	---	---	---	---
V/C Ratio 4/	.75	.75	.75	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	.85	---	---	---	---	---	---
Surface Type 5/	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	5	5	5
Horizontal Alignment 6/	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
Vertical Alignment 7/	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3

1/ Terrain types are Flat, Rolling, and Mountainous.
2/ For collectors with less than 250 ADT, surface width is used instead of lane width.
3/ Code 2: Stabilized; Code 3: Earth
4/ V/C Ratio is used only for sections in densely developed areas. Operating speed is usually used in rural areas.
5/ Code 2: High Flexible; Code 3: Intermediate; Code 4: Low; Code 5: Gravel
6/ Code 2: All curves can be safely and comfortably negotiated at the prevailing speed limit; Code 3: Some curves might require reduced speed.
7/ Code 2: All grades and vertical curves provide sufficient sight distance for safe travel and do not substantially affect the speed of trucks; Code 3: Infrequent occurrances of limited sight distance and slow trucks on hills.

Table III-19
1983 HPMS Deficiency Analysis
Urban Minimum Tolerable Condition Table

Highway Characteristic	Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors
Operating Speed:					
Built-Up Areas	30	30	---	---	---
Outlying Areas	35	30	---	---	---
Volume-to-Capacity-Ratio	.90	.90	.90	.95	.95
Lane Width (ft.)	12	11	10	8	8
Surface Type[1/]	2	2	2	3	4
Pavement Condition (PSR)	3.2	3.0	2.8	2.4	2.0
Shoulder Type[2/]	1	1	2	3	3
Right Shoulder Width (ft.)	8	8	6	6	6

[1/] Code 2: High flexible; Code 3: Intermediate; Code 4: Low

[2/] Code 1: Surfaced; Code 2: Stabilized; Code 3: Earth

Figure III-1

Growth in Travel in the United States 1970-1985 (All Highways and Local Roads)

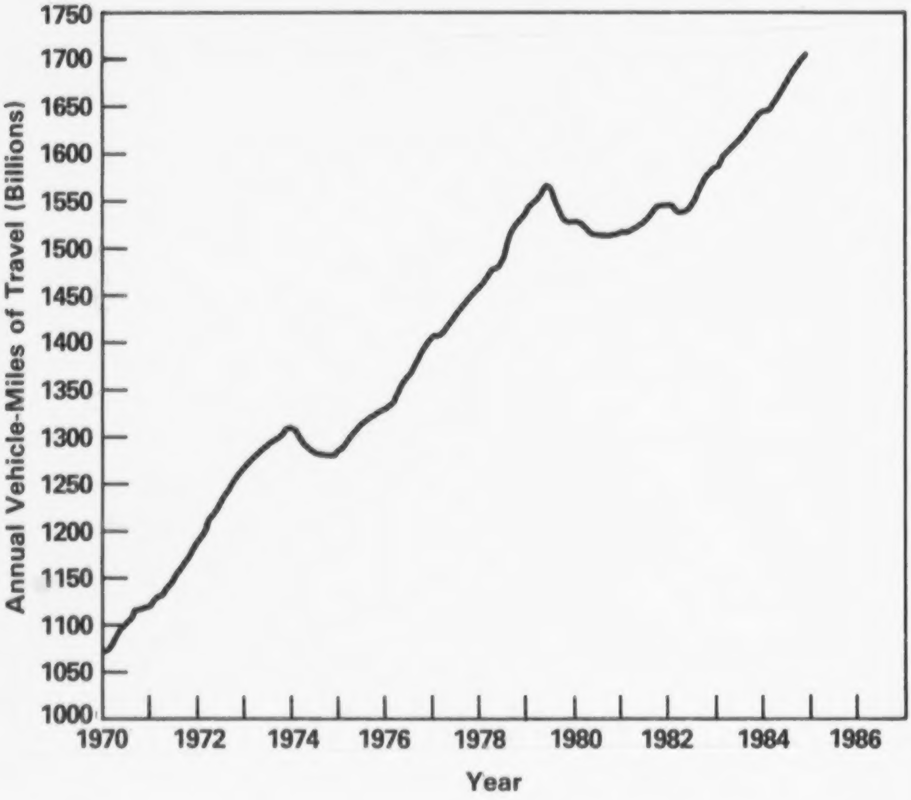


Figure III-2
Present Serviceability Rating (PSR)

PSR	Verbal Rating	Description
5		
	Very Good	Only new (or nearly new) pavements are likely to be smooth enough and sufficiently free of cracks and patches to qualify for this category. All pavements constructed or resurfaced recently should be rated very good.
4		
	Good	Pavements in this category, although not quite as smooth as those described above, give first-class ride and exhibit few, if any visible signs of surface deterioration. Flexible pavements may be beginning to show evidence of rutting and fine random cracks. Rigid pavements may be beginning to show evidence of slight surface deterioration, such as minor cracks and spalling.
3		
	Fair	The riding qualities of pavements in this category are noticeably inferior to those of new pavements, and may be barely tolerable for high-speed traffic. Surface defects of flexible pavements may include rutting, map cracking, and more or less extensive patching. Rigid pavements in this group may have a few joint failures, faulting and cracking, and some pumping.
2		
	Poor	Pavements that have deteriorated to such an extent that they are in need of resurfacing.
1		
	Very Poor	Pavements which are in an extremely deteriorated condition and may even need complete reconstruction.
0		

Figure III-3

Sequence of Deterioration

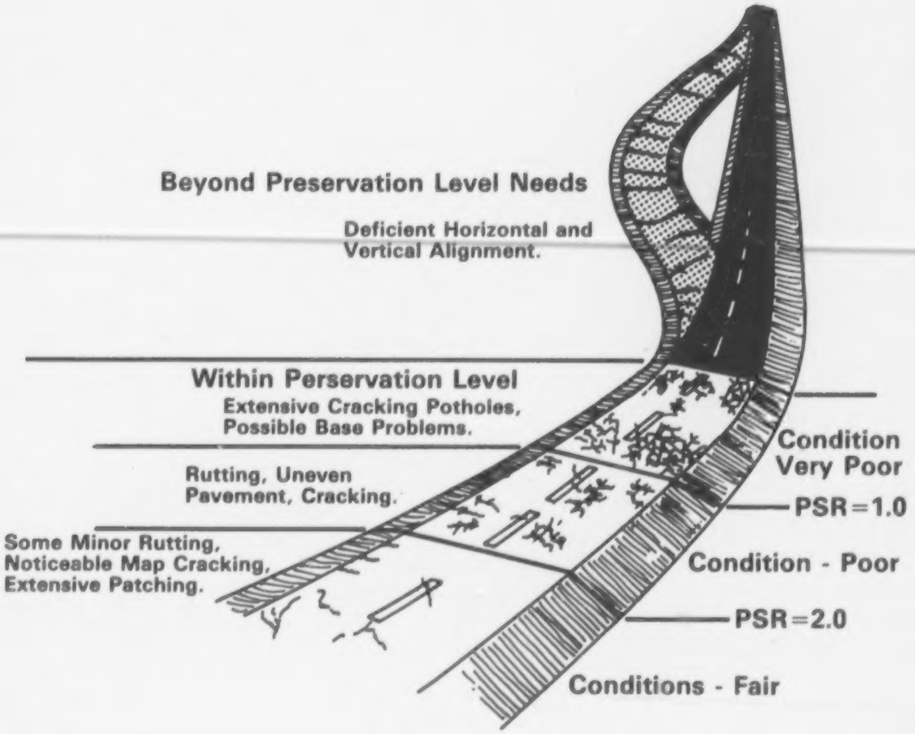

Beyond Preservation Level Needs
Deficient Horizontal and Vertical Alignment.
Within Perservation Level
Extensive Cracking Potholes, Possible Base Problems.
Rutting, Uneven Pavement, Cracking.
Some Minor Rutting, Noticeable Map Cracking, Extensive Patching.
Condition Very Poor
PSR=1.0
Condition - Poor
PSR=2.0
Conditions - Fair

Figure III-4

URBAN INTERSTATE PAVEMENT CONDITION - 1983

PERCENT MILES WITH PSR < OR = 2.5

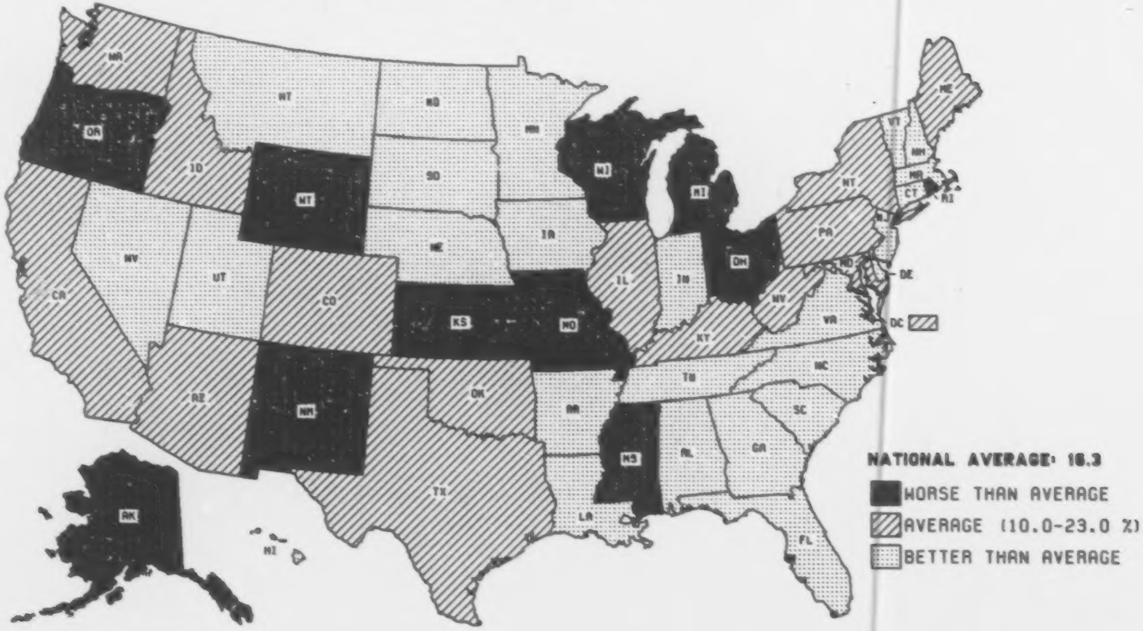

WA
OR
ID
MT
WY
NV
UT
CA
CO
AZ
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MI
IN
OH
KY
TN
MS
AL
GA
FL
SC
NC
VA
WV
PA
NY
MD
DE
NJ
DC
VT
NH
ME
MA
CT
RI
AK
HI
NATIONAL AVERAGE: 16.3
WORSE THAN AVERAGE
AVERAGE (10.0-23.0 %)
BETTER THAN AVERAGE

Figure III-5

RURAL INTERSTATE PAVEMENT CONDITION - 1983

PERCENT MILES WITH PSR < OR = 2.5

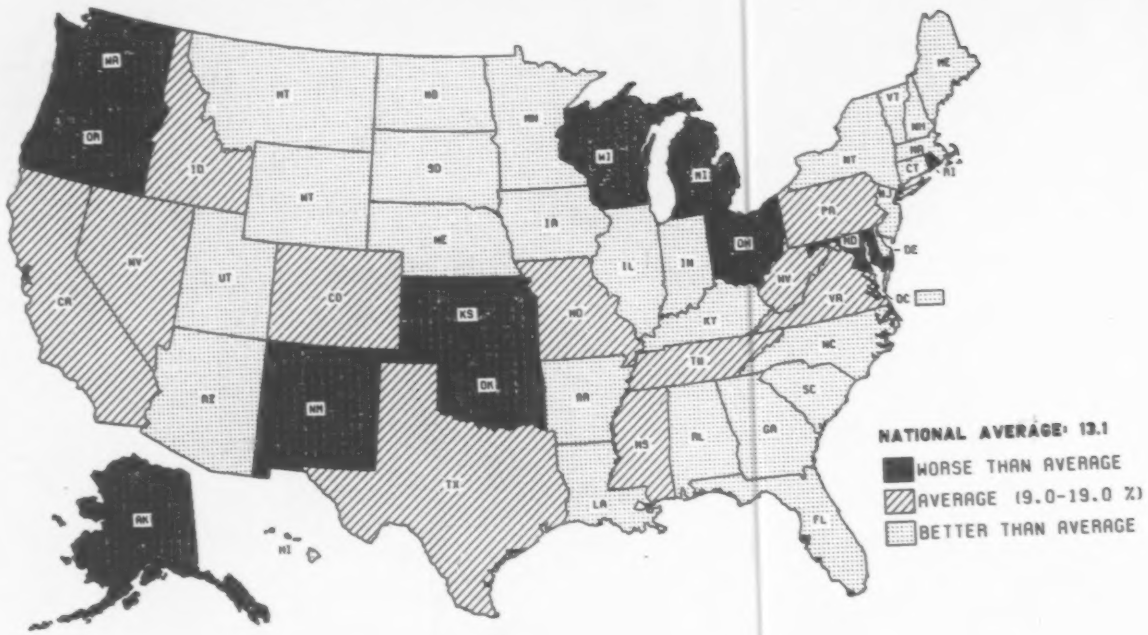
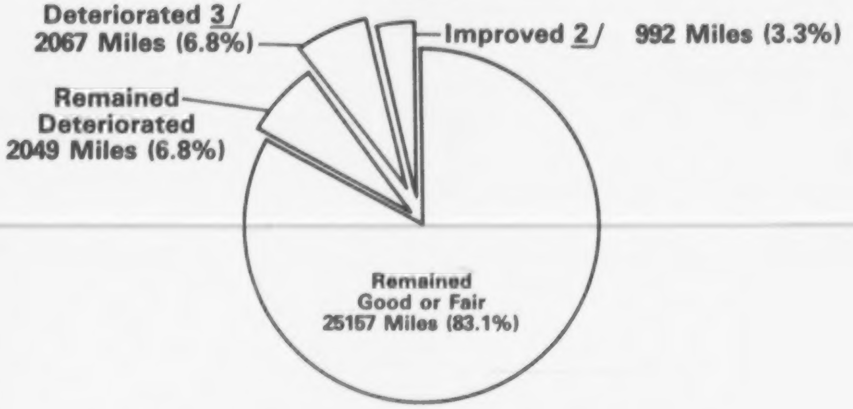

WA
OR
ID
MT
ND
MN
WI
MI
NY
VT
NH
ME
MA
CT
RI
NJ
PA
OH
IN
IL
IA
SD
WY
NE
NV
UT
CA
CO
KS
MO
KY
WV
VA
MD
DE
DC
NC
TN
AR
OK
NM
AZ
TX
LA
MS
AL
GA
SC
FL
AK
HI
NATIONAL AVERAGE: 13.1
WORSE THAN AVERAGE
AVERAGE (9.0-19.0 %)
BETTER THAN AVERAGE

Figure III-6

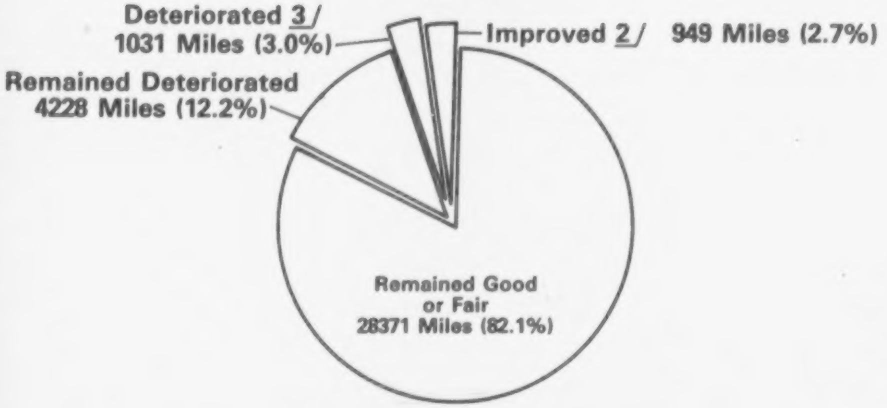
Changes 1/ in Pavement Condition on Interstate Highway for the Period 1980-1983 In Miles and (Percent) of Total

Interstate System
1980-1982



Base on 30,265 Expanded Sample Miles

Interstate System
1982-1983



Based on 34,579 Expanded Sample Miles

1/ Based on an analysis of individual highway sections that were included in the Highway Performance Monitoring System sample for more than one sampling period.

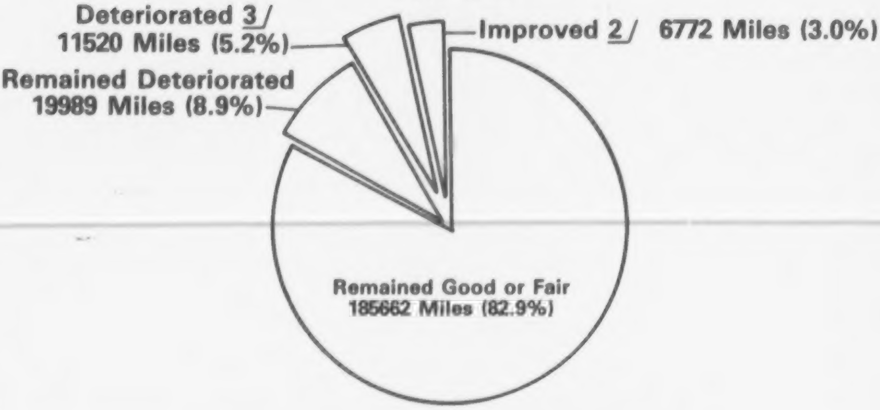
2/ Changed from a Present Serviceability Rating (PSR) at or below 2.0 (2.5 for Interstate) to a PSR greater than 2.0 (2.5 for Interstate).

3/ Changed from a PSR greater than 2.0 (2.5 for Interstate) to a PSR at or below 2.0 (2.5 for Interstate).

Figure III-7

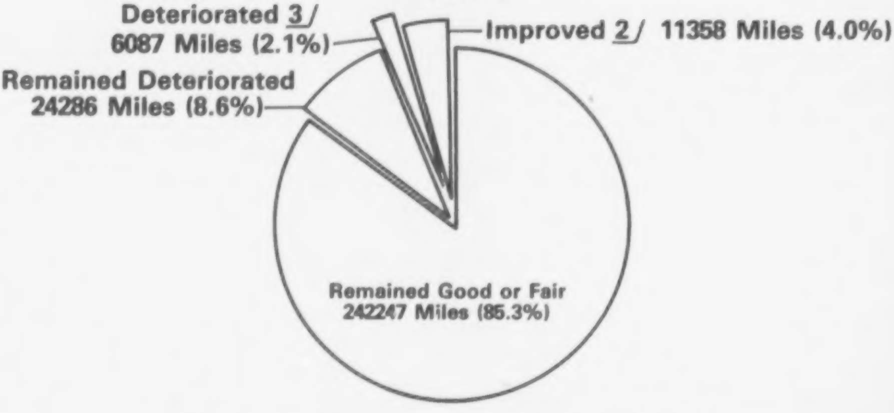
Changes 1/ in Pavement Condition on Non Interstate Arterials for the Period 1980-1983 In Miles and (Percent) of Total

Non-Interstate Arterials
1980-1982



Base on 223,943 Expanded Sample Miles

Non-Interstate Arterials
1982-1983



Based on 283,978 Expanded Sample Miles

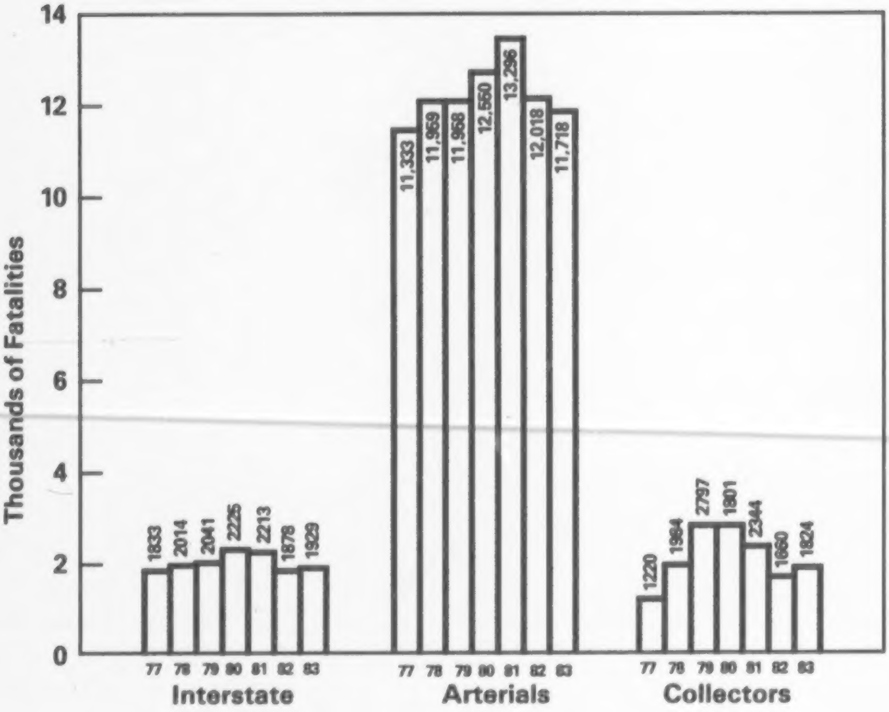
1/ Based on an analysis of individual highway sections that were included in the Highway Performance Monitoring System sample for more than one sampling period.

2/ Changed from a Present Serviceability Rating (PSR) at or below 2.0 (2.5 for Interstate) to a PSR greater than 2.0 (2.5 for Interstate).

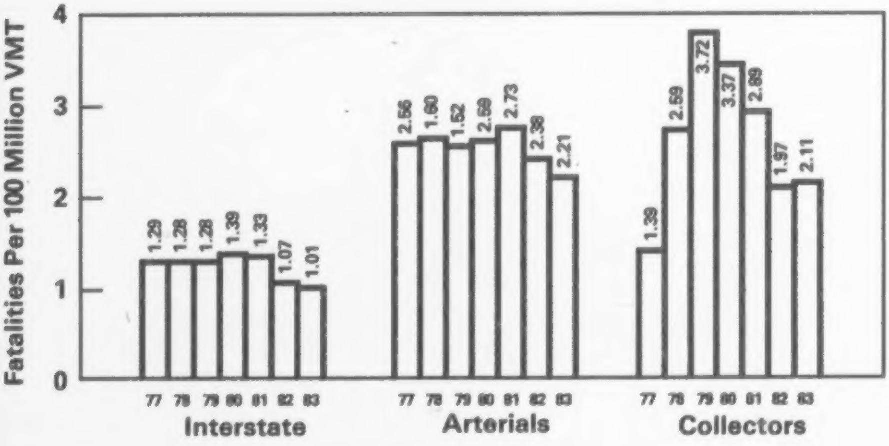
3/ Changed from a PSR greater than 2.0 (2.5 for Interstate) to a PSR at or below 2.0 (2.5 for Interstate).

Figure III-8

Urban Highway Fatalities



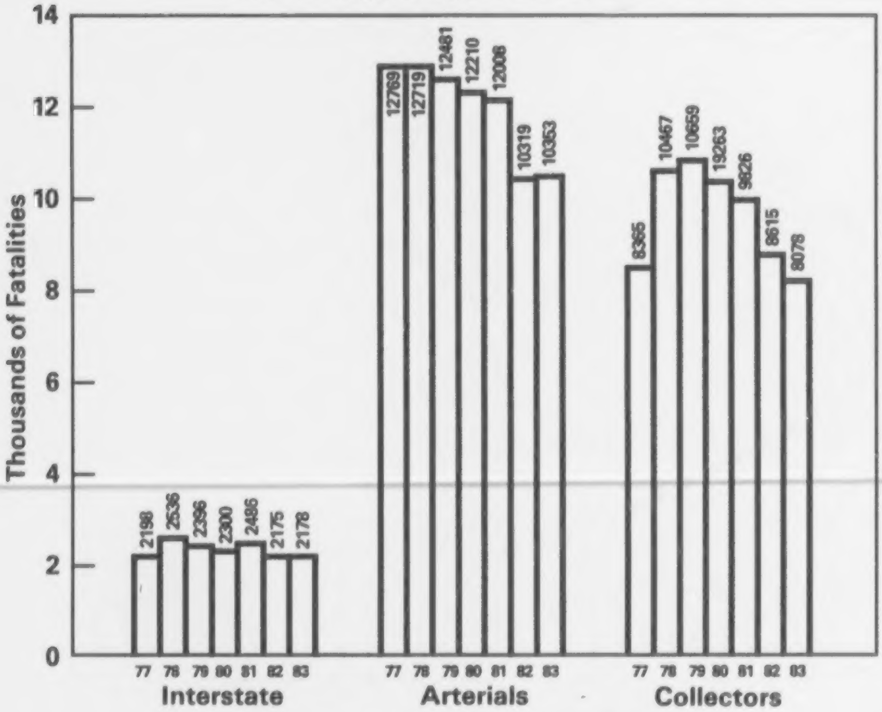
Urban Highway Fatal Accident Rates (Fatalities Per 100 Million VMT)



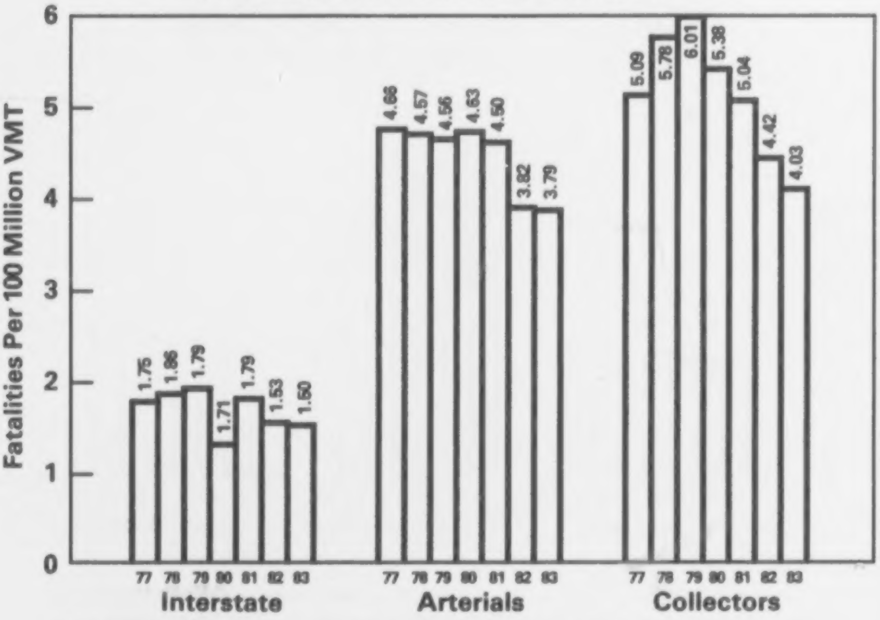
All fatality and fatality rate figures are based on the "Fatal and Injury Accident Rates" reports. The figures for 1977 and 1978 were reduced by 2% to convert them from a 1 year to a 30 day fatality definition.

Figure III-9

Rural Highway Fatalities*



Rural Highway Fatal Accident Rates* (Fatalities Per 100 Million VMT)

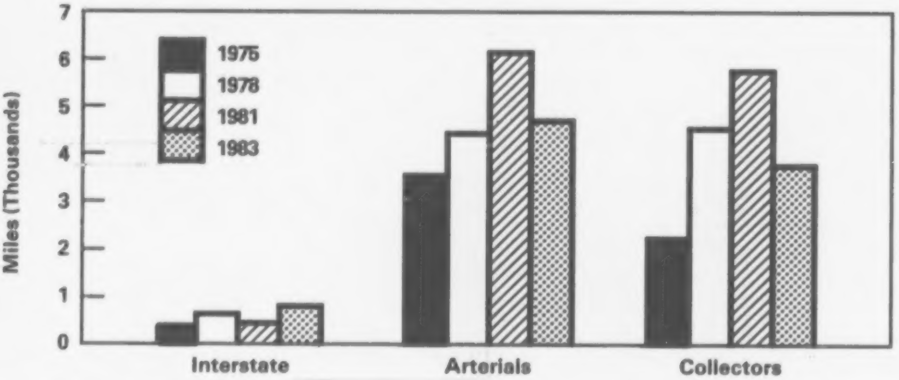


*All fatality and fatality rate figures are based on the "Fatal and Injury Accident Rates" reports. The figures for 1977 and 1978 were reduced by 2% to convert them from a 1 year to a 30 day fatality definition.

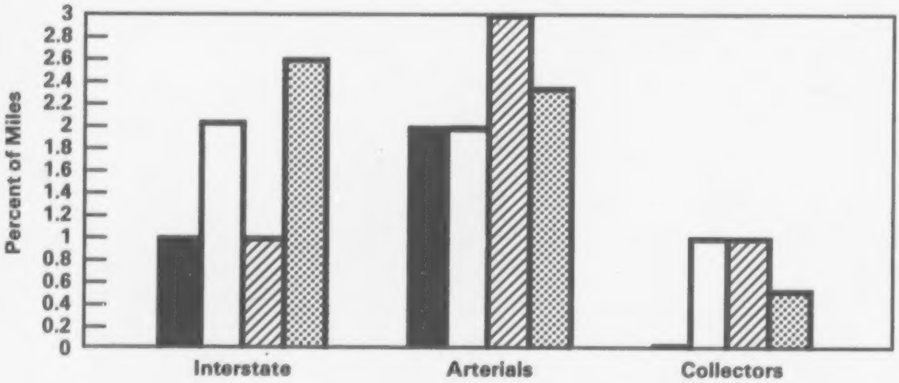
Figure III-10

Congestion on Rural Highways*

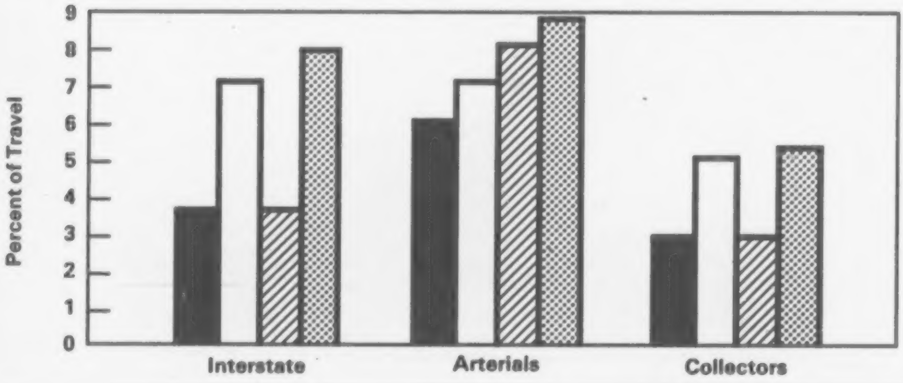
Congestion Based on Miles



Congestion Based on Percent of Total Miles



Congestion Based on Percent of Total Travel

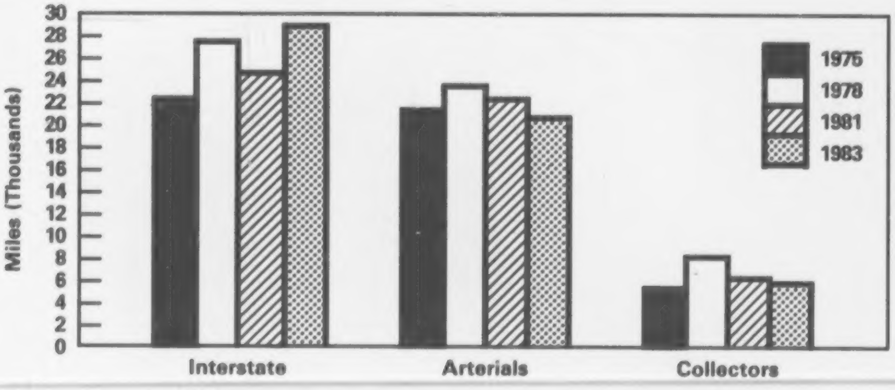


*Congestion = V/C Ratio Greater than 0.80 during peak periods

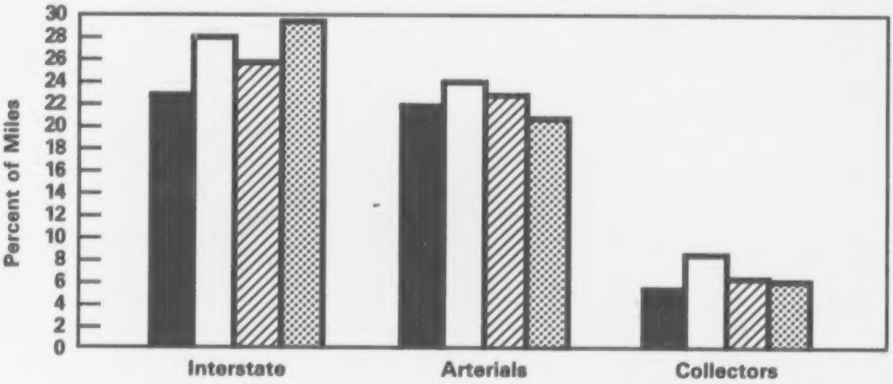
Figure III-11

Congestion* on Urban Highways

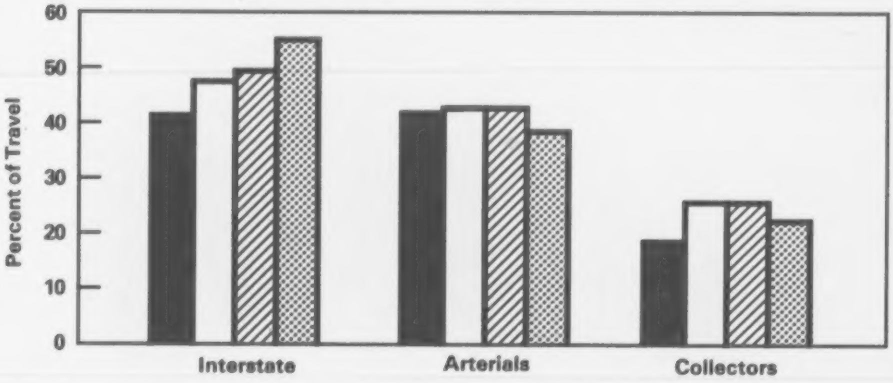
Congestion Based on Miles



Congestion Based on Percent of Total Miles



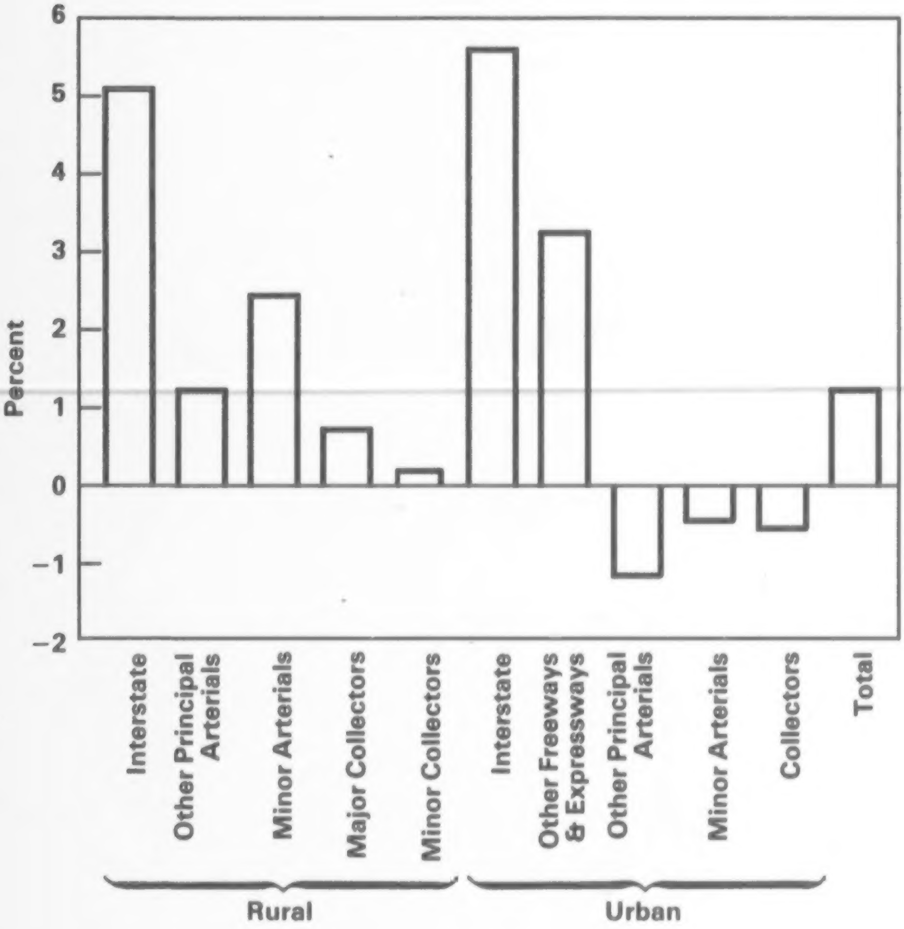
Congestion Based on Percent of Total Travel



*Congestion = V/C Ratio Greater than 0.80 during peak periods

Figure III-12

Percent Change in Unit Cost of Travel 1983 Over 1980



CHAPTER IV
HIGHWAY NEEDS: 1983-2000

Summary

- Travel is estimated by the States to increase at the rate of 2.74 percent per year through the year 2000. It grew at a rate of 3.6 percent in 1983 and at an annual rate of 4.7 percent for the first half of 1984. Between 1970 and 1980, travel grew at the average rate of 2.87 percent.

- On a scale of 0 to 100 (100 being ideal), overall system condition is approximately 84, varying between 90.8 for the Interstate System and 80 for all collectors. Principal arterials in urbanized areas have the lowest rating (67.4) of any individual functional system.

- Between 1983 and the year 2000, approximately 41,000 miles of Interstate, 334,000 miles of arterial, and 636,000 miles of collector pavement will require resurfacing or reconstruction.

- The cost of maintaining overall conditions will vary from $324 - $296 billion based on a range of 2.0 - 2.74 percent annual travel growth.

- The cost to maintain average 1983 unit user costs (operating cost, travel time, and accident costs) will vary from $399 - $353 billion.

- Meeting full needs varies from $481 - $447 billion and the cost of meeting unconstrained needs will be from $612 - $547 billion.

- The cost to correct existing bridge deficiencies by the year 2000 are $45.4 billion plus $8.5 billion for Interstate bridge needs not eligible for the Highway Bridge Replacement and Rehabilitation Program (discussed more fully in Chapter V).

INTRODUCTION

Future highway needs and conditions are a function of three interrelated factors: present conditions, future travel and levels of investment. The preceding chapter described in detail the conditions and performance of the Nation's nonlocal highways in 1983, as reported by the HPMS. This chapter describes the expected demand for highway service through the end of the century based on estimated travel. It also discusses the costs of meeting different levels of service using the HPMS analytical methodology.

The material in this chapter is neutral in terms of program responsibility. Needs are assessed without regard to jurisdictional responsibility, revenue availability, distribution of costs by vehicle type, or any other factor that will, no doubt, affect future investment levels and program directions. The intent of the chapter is to measure needs objectively, not to indicate who should bear the responsibility of meeting needs or how they should be met.

Earlier versions of this report included estimates for extensive new highway construction and upgrading of existing facilities. For example, the first report included widespread urban freeway construction and paving of all 2.6 million miles of local roads. For these reasons, the earlier needs estimates were greatly inflated beyond reasonable levels of expectation.

In recent reports we have significantly reduced the scope of needs. We have eliminated local roads from consideration, mainly because of a lack of usable data at the national level, and we have established minimum conditions standards to allow us to measure needs systematically. We have also identified the infeasibility of adding capacity in heavily congested urban areas where right-of-way is at a premium and would probably inhibit major construction or widening. This final item has been a limiting factor on simulated urban needs, restricting the estimate of future needs based on a subjective appraisal of what can and cannot be done to alleviate congestion in urban areas. In this report we examine the nature of these "unmet" needs by describing the extent of right-of-way constraints and the likely costs of mitigating capacity problems in these areas by extraordinary measures beyond those normally simulated by the analytical process.

HIGHWAY TRAVEL: 1983 - 2000

The 1981 and 1983 versions of this report included summaries of travel estimates through the year 2000. These were used to generate future travel scenarios for developing a range of needs estimates.

Several determinants of highway travel can be described as economic or social parameters. Although some of these have fluctuated recently (described in Chapter VI), there are indications that the long-term trend remains essentially unchanged. We expect travel to grow at a rate of from 2.0 percent to 2.74 percent per year through the year 2000. This is slower than in the 1970's but still represents an increase of 680 billion to 997 billion VMT between 1983 and 2000. Travel in 1983 was 1,649 billion VMT.

The needs estimates in this chapter are based on different travel growth rates by State and functional system. In the case of the high travel estimate, 2.74 percent per year, the aggregate growth rate is an accumulation of State supplied VMT estimates by system. This is slightly less than the 2.8-percent growth rate indicated by the States and used in the 1983 report, but well within the range of other, independently prepared travel forecasts. As in the last report, the State supplied forecast is used as the high end of a travel range for purposes of estimating needs. The low case, 2.0 percent, is based on a section-by-section reduction in travel such that the overall growth is 2.0 percent per year. To place these in context, VMT grew at 3.6 percent for 1983, and at an annual rate of 4.7 percent for the first 6 months of 1984. For the decade 1970-1980, travel grew at an annual average of 2.87 percent. The State forecast of 2.74 percent will underestimate future travel if current rates continue.

We expect travel by vehicle class to grow differently, as well. Automobile travel will continue to dominate in the year 2000 as in 1983. Its share will decline from nearly 75 percent now to 69 percent in 2000. Personal use of vans and pickup trucks will continue to grow at its current rapid pace. These vehicles will maintain their share of overall travel and will capture a greater share of personal highway travel.

The highway share of freight transport will continue to grow through the year 2000, with trucks accounting for approximately 22.5 percent of ton-miles of travel. Truck growth rate will exceed automobile growth, and by the year 2000, trucks will account for a larger share of total highway travel.

METHODOLOGY: ASSESSING VMT IMPACTS ON THE 1983 SYSTEM

The first step in predicting future needs is to estimate the effects of travel and deterioration on the highway network. Each section in the HPMS sample is analyzed independently for each year of the analysis period, in this case, 1983 through 2000. Travel is simulated on the section and resulting conditions are compared with a prescribed set of minimum conditions standards. When one or more of these minimum conditions standards is exceeded, the methodology notes a deficiency and simulates an appropriate capital improvement to correct the deficiency. The improvement simulated depends on the nature and extent of the deficiency(ies). For each section, the HPMS input record is modified to reflect changes in travel demand and pavement condition for each year over the analysis period. The base year values for V/C (volume to capacity ratio, a measure of congestion) and operating speed are also recomputed. Pavement deterioration is based on a modified version of the American Association of State Highway and Transportation Officials (AASHTO) road test equations.

The pavement history of a section is established by estimating the equivalent number of 18-kip axle loadings applied to the pavement prior to the 1983 base year. Future axle loadings are then calculated for the analysis period using the HPMS sample input records for future auto and truck travel and the pavement is then deteriorated in accordance with the AASHTO equations. The auto/truck split varies according to future travel forecasts. The truck type distribution is based on FHWA case studies conducted in 1982. Any future mix of truck types can be used to test the effects of vehicle combinations on highway conditions, but for this analysis, the 1982 values were used.

Minimum condition standards (MCS) were set for this analysis after extensive collaboration between FHWA and the States. States were asked to review the MCS's used for the 1983 report and recommend changes where necessary, to bring the minimum standards in line with actual State practices. Although the responses varied, in general the States suggested that our Interstate and arterial MCS's were too low and collector MCS's too high. They also recommended a subcategorization of principal arterials into higher and lower traffic volume groupings. All of these recommendations were adopted and are incorporated into the analysis procedures, the results of which are reported in this chapter. Tables III-17 and III-18 (previous chapter) show the rural and urban MCS's used in this report.

Deficiencies identified using the above procedure are "improved" within the simulation to a set of designated design standards. Reconstruction improvements bring pavements to a condition equal to new AASHTO construction standards. In the cases of widening and resurfacing, the improved condition is on a sliding scale. Thus, the improved condition of an extremely deteriorated pavement is less than that of a marginally deficient pavement, and is less than new AASHTO construction standards.

Design standards for nondeteriorating conditions such as lane width or shoulder width are set to the appropriate construction standards that are currently in effect for that functional system. This implies a continuous improvement in overall system conditions as deficiencies are removed by construction to more stringent design standards. All costs are shown in 1983 constant dollars.

One more element of the HPMS analytical methodology has become a major point of interest as States have implemented rigorous pavement management practices in recent years. The HPMS methodology uses one resurfacing strategy, regardless of available revenue, programming policies, or any other factors that might be used to tailor pavement improvement programs. The methodology assumes that improvements will be made when the pavement condition violates the MCS (unless another MCS is violated, in which case the pavement may be better than minimum standard). The methodology also assumes a single thickness of overlay for resurfacing.

More frequent applications of thinner overlays may be a more cost-effective approach to achieving long-term pavement life than allowing pavements to deteriorate to a fair to poor condition and then resurfacing with a thick overlay. This theory is being tested in many States, but as yet, we do not have a sufficient empirical data base with which to evaluate and adopt one of these strategies.

The Extent of Future Highway Deterioration

Chapter III described highway deficiencies as of 1983 on the various functional systems. In assessing needs we refer to these as backlog deficiencies. Over time, all highways, including those that are already deficient will wear out through the effects of normal aging, weather, deicing salts, and wheel loads. Governmental agencies with highway responsibilities will continue to invest in these roads to reconstruct or resurface worn surfaces, improve sight distance and straighten curves to improve safety, and add capacity to alleviate congestion. All of these improvements and the substantial costs they impose are aimed at eliminating backlog deficiencies and addressing deficiencies that will accrue in the future.

In order to indicate the magnitude and continuing nature of this situation, we have included Figures IV-1 through IV-6. These figures illustrate the extent of pavement that is either currently deficient or would become deficient through the end of the century without further capital investment, assuming the 2.74 percent annual growth in travel mentioned earlier. Approximately 41,000 miles of Interstate pavement, 334,000 miles of arterial pavement, and 636,000 miles of collector pavement either are, or would become deficient through the year 2000. Obviously, capital investments will continue to be made on the systems and we can not reasonably expect the roads to be in such dire condition in the year 2000 as suggested by the figures. However, these figures do indicate why there is such a continuing interest in adequate highway investment.

Investment/Performance Relationships

In the earliest reports we estimated only the costs of removing all deficiencies on the highway systems and reported this as needs. We gradually replaced this concept of needs in the mid-1970's based on theoretical and empirical advancements in research conducted by the Federal and State governments, AASHTO, and several leading universities. This research, and the development of the HPMS, enabled us to formulate investment/performance relationships for the highway system. These relationships, a representation of which is shown as Figure IV-7, allow us to estimate the future performance on the system given an investment pattern and level, future travel estimates, and applicable standards.

The curve in Figure IV-7 represents levels of overall performance that can be expected from the investment of highway capital through the end of the century. The vertical axis is a composite measure of performance composed of physical, operating, and safety factors weighted for each functional system according to the most sensitive and volatile factor affecting each system's performance. In other words, rural systems generally receive a slightly higher weighting on pavement since the States address rural highway needs primarily through pavement management strategies. On the other hand, the higher levels of travel demand on urban roads place a greater burden on meeting capacity rather than pavement needs, and they are weighted accordingly. We will address the urban capacity problems in greater detail later in this chapter. Safety is a major concern on all systems and is weighted equally in urban and rural areas.

The horizontal dashed line on Figure IV-7 represents the 1983 performance index on all systems. Performance on each system actually varies and different curves are prepared for each system, but for the purpose of explanation here, assume that the systems and curves, are identical. The intercepts of the dashed line on the two curves, each of which represents a different travel forecast discussed earlier, are the sums necessary through the year 2000 expressed in constant 1983 dollars to keep the various systems at their current overall condition. Similar intercepts for other desired levels of performance would yield different needs estimates depending on the slopes of the curves.

Overall here is the key word. Since we are assessing the costs of maintaining an overall condition, elements of that condition may improve, decline, or stay the same, so long as the overall condition is unchanged. Figures IV-8 and IV-9 represent the distributions of pavement condition in the year 2000 for two functional systems compared to the 1983 distributions assuming a cost-to-maintain investment strategy. Note that in some cases, the variations in pavement condition are significant. This implies that at some later date, even assuming that sufficient funds are invested at appropriate intervals to maintain conditions, the surface of the roadway may appear deteriorated as compared to 1983 conditions. However, when improvements to safety and other performance measures are taken into consideration, the overall condition has remained essentially unchanged.

Another way of describing this is shown in Figure III-12 in the previous chapter and in the Appendix. Between 1980 and 1983 user costs increased from $481.21/1000 VMT to $487.39/1000 VMT, a 1.3-percent change. By using the methodology described in the Appendix, we estimate that total user cost (vehicle operating cost, accident, and travel time costs) will increase to $492.31 in the year 2000 under the maintain physical condition scenario, a 1.0-percent increase over the 1983 base.

Accident costs will decline on all but one functional system as safety improvements are made to improve geometry and cross section. Travel time costs will increase significantly on urban systems due to the constraints on capacity additions. Operating cost changes will vary by systems.

FUTURE HIGHWAY NEEDS THROUGH 2000

Tables IV-1 through IV-3 show the full needs on all nonlocal highways through the year 2000 and type of improvements simulated. Tables IV-4 through IV-6 show costs for maintaining the 1983 composite index on each system. Tables IV-7 through IV-9 show the costs of maintaining average vehicle operating cost and speed on each system through the year 2000. Tables IV-10 through IV-12 show the costs of meeting full needs assuming no right-of-way constraints.

Full needs do not imply system perfection. It means that investments equivalent to those shown will secure a system condition through the end of the century where no highway segment exhibits physical or operating characteristics below the minimum condition standards. If 100, on a scale of 0-100, represents perfection, that is, all highways exhibit characteristics of brand new roads, then full needs represents a level that can range anywhere from the maximum of 100 down to approximately 70 on the composite index scale, the point at which the minimum condition standards would signal a deficiency. Theoretically, if the distribution of conditions on each segment of highway within a functional system were exactly even, the full needs composite index would be 85 on each system. As Figures IV-10 through IV-12 illustrate, the distribution is, in fact, not even, but varies significantly for each system. Point A on each figure is the composite index for full needs. Point B is the 1983 composite index, and C is the composite that would result from an investment strategy to maintain overall rates of vehicle operating cost. Point D would result from no investment through 2000.

Note that on the Interstate System, full needs result in a composite index of 91 while on the collectors, the same type of investment strategy yields an 82.2 index. As described above, this means that even though no deficiencies would exist in the year 2000 at the full investment level on these systems, the overall condition on the Interstate would be appreciably higher than on the collectors.

As mentioned earlier, in previous reports we "screened" needs by applying widening feasibility constraints identified by the States. The use of this constraint affects urban needs much more than rural needs because right-of-way restrictions are more predominant in urban areas. For example, according to HPMS sample records, only 11 percent of rural Interstate mileage could not accommodate added capacity through widening because of physical constraints on expansion. Conversely, almost 30 percent of urban Interstate mileage falls in this category. Of all nonlocal roads, approximately 18 percent of rural roads and 40 percent of urban roads cannot accommodate significant widening. The estimates included in Tables IV-10 through IV-12 override these constraints. Although miles of improvement are not included in any of the tables in this chapter, we should note that unconstrained needs add substantially to the cost, but only marginally to miles of improvement. The higher needs estimates are the result of higher unit costs for improvements, reconstruction with added lanes, for example, rather than minor widening. In fact, unconstrained needs would probably be significantly higher than those shown in Table IV-10 because of the extraordinary measures that would be required to meet these needs.

Point E, in Figures IV-10 through IV-12, illustrates the level of performance and costs of meeting these unconstrained needs. As the reader will note, the costs are substantial when compared to the overall system -benefits as measured by the investment/performance methodology. Nonetheless, these estimates indicate the costs that would reasonably apply if decisionmakers and the public were committed to satisfying urban highway travel demand using conventional construction techniques.

Bridge Needs

Table IV-13 shows existing bridge needs as reported in the 1984 Highway Bridge Replacement and Rehabilitation Report to Congress. This table does not include the costs of repairing or replacing bridges that will become deficient between now and the year 2000. As the footnote on Table IV-13 reports, there are $8.5 billion in Interstate bridge needs in addition to the $2.1 billion included in the 1985 Highway Bridge Replacement and Rehabilitation Report (HBRRP) to Congress. These are estimates to repair Interstate bridges that are not deteriorated enough to be eligible for the HBRRP program, but are considered structurally or functionally deficient to the point that they warrant being termed needs.

Similar situations exist on other functional and Federal-aid systems, but they have not yet been quantified and are, therefore, not included in this Report.

Table IV-1
Estimated Capital Investments for 1983-2000 to Remove All Deficiencies by Functional Class
(In billions of 1983 dollars)

	URBAN FUNCTIONAL SYSTEMS						RURAL FUNCTIONAL SYSTEMS					
Travel Growth (Percent Year)	Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors	Total	Interstate	Other Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Total
2.74	37.35	18.72	71.07	56.12	38.95	222.21	24.44	53.00	47.30	86.77	47.75	259.26
2	33.05	16.62	65.51	52.07	37.25	204.50	21.24	48.17	44.44	82.81	45.71	242.37

Total Urban and Rural

VMT	Urban	Rural	Total	Billions of Dollars/ Year
2.74	222.21	259.26	481.47	26.75
2	204.50	242.37	446.87	24.83

Table IV-2
Rural Highways (Full Needs, 1983-2000)
(In millions of 1983 dollars)

Rate of Travel Growth (percent per year)	Interstate		Other Principal Arterials		Minor Arterials		Major Collectors		Minor Collectors		Total	
	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruction to freeway standards	0	0	19,979	14,110	0	0	0	0	0	0	19,979	14,110
Reconstruction with added lanes	1,487	814	3,620	2,952	3,522	2,048	1,643	1,430	728	156	11,000	7,400
Reconstruction with wider lanes	16	18	1,866	1,872	3,038	3,247	11,765	11,149	7,247	6,177	23,932	22,463
Pavement reconstruction	1,420	1,215	4,268	4,455	5,157	5,282	35,389	34,336	24,032	24,185	70,266	69,473
Isolated reconstruction	152	169	2,438	2,187	7,096	7,066	11,709	9,938	3,885	3,508	25,280	22,868
Major widening	7,183	5,317	4,287	2,985	6,402	4,266	4,277	3,003	400	89	22,549	15,661
Minor widening	2	2	1,252	1,164	813	809	2,847	3,264	2,103	2,421	7,018	7,660
Resurfacing	14,106	13,619	14,651	16,864	19,531	19,856	17,157	17,985	8,174	8,159	73,618	76,483
Resurfacing with alignment or shoulder improvement	75	90	636	1,582	1,739	1,868	1,974	1,705	1,180	1,011	5,603	6,256
Total	24,441	21,244	52,996	48,171	47,298	44,443	86,761	82,810	47,749	45,705	259,245	242,373

Table IV-3
Urban Highways (Full Needs, 1983-2000)
(In millions of 1983 dollars)

	Interstate		Other Freeways		Other Principal Arterials		Minor Arterials		Collectors		Total	
Rate of Travel Growth (percent per year)	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruct to freeway	141	133	1,326	930	0	0	0	0	0	0	1,466	1,063
Reconstruct with more lanes	5,627	4,620	1,172	942	3,344	2,360	1,683	798	270	135	12,096	8,855
Reconstruct with wider lanes	78	58	132	132	1,200	1,130	171	152	153	120	1,735	1,592
Pavement reconstruction	2,817	2,407	1,151	990	6,711	6,153	4,565	4,482	2,277	2,041	17,521	16,073
Major widening	12,892	10,883	7,484	6,129	21,850	18,272	15,609	12,415	6,207	4,591	64,043	52,291
Minor widening	44	25	212	88	3,338	2,912	3,018	2,917	1,724	1,625	8,335	7,567
Resurfacing with shoulder	613	528	1,348	1,398	4,802	5,012	6,329	6,421	9,076	9,117	22,168	22,477
Resurfacing	15,138	14,396	5,894	6,010	25,196	25,707	20,558	20,953	17,891	18,325	84,678	85,390
Traffic engineering	0	0	0	0	4,630	3,970	4,188	3,932	1,354	1,290	10,172	9,192
Total	37,350	33,051	18,718	16,619	71,072	65,516	56,121	52,071	38,953	37,243	222,214	204,500

Table IV-4
Estimated Capital Investments for 1983-2000 to Maintain Overall 1983 Conditions by Functional Class
(In billions of 1983 dollars)

	URBAN FUNCTIONAL SYSTEMS						RURAL FUNCTIONAL SYSTEMS					
Travel Growth (Percent Year)	Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors	Total	Interstate	Other Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Total
2.74	33.17	14.69	44.89	40.58	29.82	163.15	21.82	29.59	33.92	52.28	23.19	160.80
2	30.96	12.87	40.00	36.97	28.49	149.29	18.55	24.98	31.62	49.58	22.04	146.77

Total Urban and Rural

VMT	Urban	Rural	Total	Billions of Dollars/ Year
2.74	163.15	160.80	323.95	18.00
2	149.29	146.77	296.06	16.45

Table IV-5
Rural Highways (Cost to Maintain 1983 Conditions, 1983-2000)
(In millions of 1983 dollars)

	Interstate		Other Principal Arterials		Minor Arterials		Major Collectors		Minor Collectors		Total	
Rate of Travel Growth (percent per year)	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruction to freeway standards	0	0	8,341	5,403	0	0	0	0	0	0	8,341	5,403
Reconstruction with added lanes	1,464	875	985	732	3,100	2,007	1,693	1,320	619	162	7,861	5,096
Reconstruction with wider lanes	0	0	1,017	1,018	1,311	1,419	6,239	5,768	3,771	3,662	12,338	11,866
Pavement reconstruction	924	887	2,359	2,260	2,663	2,678	13,158	12,707	7,426	7,331	26,531	25,863
Isolated reconstruction	136	117	1,509	949	4,664	4,618	8,572	8,380	2,230	2,205	17,111	16,269
Major widening	5,668	3,631	1,882	1,647	4,468	3,242	3,930	2,816	398	88	16,348	11,425
Minor widening	0	2	859	718	671	643	2,331	2,219	1,592	1,321	5,453	4,902
Resurfacing	13,582	13,011	12,485	12,114	16,017	15,871	14,579	14,643	6,265	6,426	62,928	62,064
Resurfacing with alignment or shoulder improvement	46	32	161	140	1,033	1,147	1,773	1,728	885	847	3,898	3,896
Total	21,821	18,555	29,599	24,981	33,927	31,625	52,275	49,581	23,187	22,041	160,808	146,784

Table IV-6
Urban Highways (Cost to Maintain 1983 Conditions, 1983-2000)
(In millions of 1983 dollars)

Rate of Travel Growth (percent per year)	Interstate		Other Freeways		Other Principal Arterials		Minor Arterials		Collectors		Total	
	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruct to freeway	104	101	902	577	0	0	0	0	0	0	1,006	678
Reconstruct with more lanes	4,836	4,260	1,274	912	2,248	1,639	1,101	761	361	230	9,820	7,803
Reconstruct with wider lanes	65	65	137	128	1,323	1,269	137	93	207	89	1,869	1,643
Pavement reconstruction	2,386	2,324	1,040	854	4,396	3,811	2,573	2,038	2,119	1,749	8,118	11,362
Major widening	10,431	8,810	4,877	3,850	9,428	7,269	7,330	6,980	4,420	3,453	36,486	30,362
Minor widening	26	18	72	62	2,265	1,824	3,353	2,727	1,376	1,317	7,092	5,946
Resurfacing with shoulder	546	549	1,065	1,041	3,162	3,248	4,882	4,775	6,658	6,702	13,150	16,229
Resurfacing	14,778	14,830	5,317	5,449	19,248	18,541	18,086	16,665	13,493	13,831	70,922	69,316
Traffic engineering	0	0	0	0	2,821	2,389	3,117	2,940	1,184	1,114	7,123	6,443
Total	33,171	30,957	14,685	12,873	44,890	39,989	40,579	36,978	29,818	28,485	163,144	149,283

Table IV-7
Estimated Capital Investments for 1983-2000 to Maintain Average 1983 Highway User Costs by Functional Class
(In billions of 1983 dollars)

	URBAN FUNCTIONAL SYSTEMS						RURAL FUNCTIONAL SYSTEMS					
Travel Growth (Percent Year)	Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors	Total	Interstate	Other Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Total
2.74	36.28	18.58	56.83	52.08	37.35	201.12	22.56	37.46	42.72	66.49	29.04	198.27
2	35.25	14.65	45.53	42.08	32.43	169.94	19.22	34.22	40.29	62.74	26.78	183.25

Total Urban and Rural

VMT	Urban	Rural	Total	Billions of Dollars/ Year
2.74	201.12	198.27	399.39	22.19
2	169.94	183.25	353.19	19.62

Table IV-8
Rural Highways, Cost to Maintain 1983 Highway User Costs, 1983-2000
(In millions of 1983 dollars)

Rate of Travel Growth (percent per year)	Interstate		Other Principal Arterials		Minor Arterials		Major Collectors		Minor Collectors		Total	
	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruction to freeway standards	0	0	10,480	7,401	0	0	0	0	0	0	10,480	7,401
Reconstruction with added lanes	1,514	906	1,247	1,003	3,903	2,557	2,153	1,670	775	197	9,592	6,333
Reconstruction with wider lanes	18	18	1,287	1,394	1,651	1,808	7,936	7,299	4,723	4,449	15,614	14,968
Pavement reconstruction	955	919	2,986	3,096	3,353	3,412	16,736	16,079	9,301	8,907	33,331	32,413
Isolated reconstruction	141	121	1,910	1,300	5,873	5,883	10,903	10,604	2,793	2,679	21,619	20,588
Major widening	5,860	3,761	2,382	2,256	5,626	4,130	4,999	3,563	498	107	19,365	13,818
Minor widening	3	3	1,240	984	845	819	2,965	2,808	1,994	1,605	7,047	6,219
Resurfacing	14,022	13,467	15,721	16,594	20,168	20,220	18,543	18,529	7,846	7,808	76,301	76,618
Resurfacing with alignment or shoulder improvement	48	33	204	192	1,301	1,461	2,255	2,187	1,108	1,029	4,916	4,902
Total	22,560	19,228	37,456	34,220	42,720	40,290	66,490	62,740	29,039	26,781	198,264	183,260

Table IV-9
Urban Highways (Cost to Maintain 1983 Highway User Costs, 1983-2000)
(In millions of 1983 dollars)

Rate of Travel Growth (percent per year)	Interstate		Other Freeways		Other Principal Arterials		Minor Arterials		Collector		Total	
	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruct to freeway	137	136	1,316	820	0	0	0	0	0	0	1,454	956
Reconstruct with more lanes	5,484	4,716	1,163	830	2,674	1,640	1,562	645	259	118	11,142	7,949
Reconstruct with wider lanes	76	59	131	116	960	785	159	123	147	104	1,472	1,188
Pavement reconstruction	2,745	2,763	1,143	873	5,366	4,276	3,423	3,622	2,183	1,777	14,860	13,311
Major widening	12,445	11,109	7,429	5,403	17,472	12,698	14,485	10,003	5,952	3,998	57,782	43,240
Minor widening	43	98	210	78	2,669	2,024	2,801	2,357	1,653	1,415	7,376	5,972
Resurfacing with shoulder	587	641	1338	1,232	3,840	3,483	5,873	5,189	8,703	7,939	20,351	18,484
Resurfacing	14,753	15,729	5,851	5,298	20,147	17,865	19,891	16,933	17,155	15,957	77,796	71,781
Traffic engineering	0	0	0	0	3,702	2,759	3,886	3,176	1,298	1,123	8,887	7,060
Total	36,280	35,251	18,581	14,650	56,829	45,530	52,080	42,079	37,349	32,431	201,119	169,941

Table IV-10
Unconstrained Needs, 1983-2000, by Functional Class
(In billions of 1983 dollars)

	URBAN FUNCTIONAL SYSTEMS						RURAL FUNCTIONAL SYSTEMS					
Travel Growth (Percent Year)	Interstate	Other Freeways & Expressways	Other Principal Arterials	Minor Arterials	Collectors	Total	Interstate	Other Principal Arterials	Minor Arterials	Major Collectors	Minor Collectors	Total
2.74	53.76	27.31	118.03	87.74	53.38	340.22	25.13	57.78	50.59	89.94	48.90	272.34
2	47.19	23.58	103.93	73.30	48.11	296.11	20.98	51.01	47.10	85.21	46.52	250.82

Total Urban and Rural

VMT	Urban	Rural	Total	Billions of Dollars/ Year
2.74	340.22	272.34	612.56	34.03
2	296.11	250.82	546.93	30.39

Table IV-11
Rural Highways (Unconstrained Needs, 1983-2000)
(In millions of 1983 dollars)

Rate of Travel Growth (percent per year)	Interstate		Other Principal Arterials		Minor Arterials		Major Collectors		Minor Collectors		Total	
	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruction to freeway standards	0	0	22,919	16,155	0	0	0	0	0	0	22,919	16,155
Reconstruction with added lanes	1,338	755	5,052	4,093	4,929	3,361	2,064	1,799	1,176	722	14,559	10,731
Reconstruction with wider lanes	18	18	1,595	1,760	3,112	3,355	13,806	12,032	8,022	7,549	26,553	24,715
Pavement reconstruction	989	1,164	3,992	4,255	5,056	5,224	35,021	34,841	23,600	23,147	68,657	68,632
Isolated reconstruction	169	169	2,268	2,273	6,944	6,949	11,398	10,993	3,723	3,697	24,503	24,081
Major widening	8,428	3,960	5,728	5,762	8,632	6,092	5,644	3,698	764	339	29,197	19,851
Minor widening	3	3	980	1,048	786	814	3,184	2,966	2,311	1,955	7,265	6,786
Resurfacing	14,105	14,817	14,676	14,956	19,448	19,554	16,848	17,007	8,151	8,095	73,229	74,429
Resurfacing with alignment or shoulder improvement	83	90	572	702	1,684	1,754	1,974	1,868	1,156	1,023	5,469	5,438
Total	25,133	20,976	57,782	51,005	50,592	47,102	89,940	85,205	48,904	46,527	272,350	250,816

Table IV-12
Urban Highways (Unconstrained Needs, 1983-2000)
(In millions of 1983 dollars)

	Interstate		Other Freeway		Other Principal Arterials		Minor Arterial		Collector		Total	
Rate of Travel Growth (percent per year)	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2	2.74	2
Reconstruct to freeway	300	287	2,243	1,788	0	0	0	0	0	0	2,543	2,075
Reconstruct with more lanes	9,650	7,570	2,858	2,433	11,103	8,597	3,259	1,549	2,032	408	28,901	20,556
Reconstruct with wider lanes	83	83	23	22	640	637	84	88	162	143	994	974
Pavement reconstruction	1,687	1,958	723	578	4,290	4,393	4,120	4,306	1,985	1,950	12,805	13,185
Major widening	25,681	21,101	14,080	11,189	62,766	49,902	47,572	36,987	19,736	15,322	169,835	134,501
Minor widening	143	96	189	180	2,927	3,131	2,607	1,918	1,807	2,022	7,673	7,347
Resurfacing with shoulder	379	432	1,212	1,267	4,251	4,543	5,938	6,041	8,885	8,935	20,665	21,217
Resurfacing	15,841	15,671	5,977	6,124	25,819	26,288	20,041	18,299	17,174	17,601	84,851	83,982
Traffic engineering	0	0	0	0	6,238	6,437	4,118	4,113	1,597	1,731	11,953	12,281
Total	53,764	47,196	27,306	23,581	118,035	103,927	87,739	73,300	53,377	48,113	340,220	296,118

Table IV-13
Estimated Backlog Bridge Deficiencies
(In 1983 dollars)
(As of December 31, 1983)

System	Bridges Eligible for Replacement or Rehabilitation Sufficiency Rating 50	Estimated Replacement Cost in Billions	Bridges Eligible for Rehabilitation Sufficiency Rating 50 - 80	Estimated Rehabilitation Cost in Billions	Total Cost in Billions
Interstate[1]	529	$ 0.4	2,880	$ 1.7	$ 2.1
Primary	7,929	5.8	12,133	4.4	10.2
Urban	3,997	3.7	4,853	1.6	5.3
Secondary	14,359	4.5	15,362	2.1	6.6
Total Federal Aid	26,814	14.4	35,228	9.8	24.2
Off-system	121,772	17.2	53,237	4.0	21.2
Total[1]	148,586	$ 31.6	88,465	$ 13.8	$ 45.4

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[1] The Federal Highway Administration estimated that at the same time another $8.5 billion in Interstate 3R/4R bridge needs existed which were not eligible for Highway Bridge Replacement Rehabilitation Program (HBRRP) funds, for example: deteriorating bridge deck surfaces.

Figure IV-1

Rural Interstate Pavement Condition

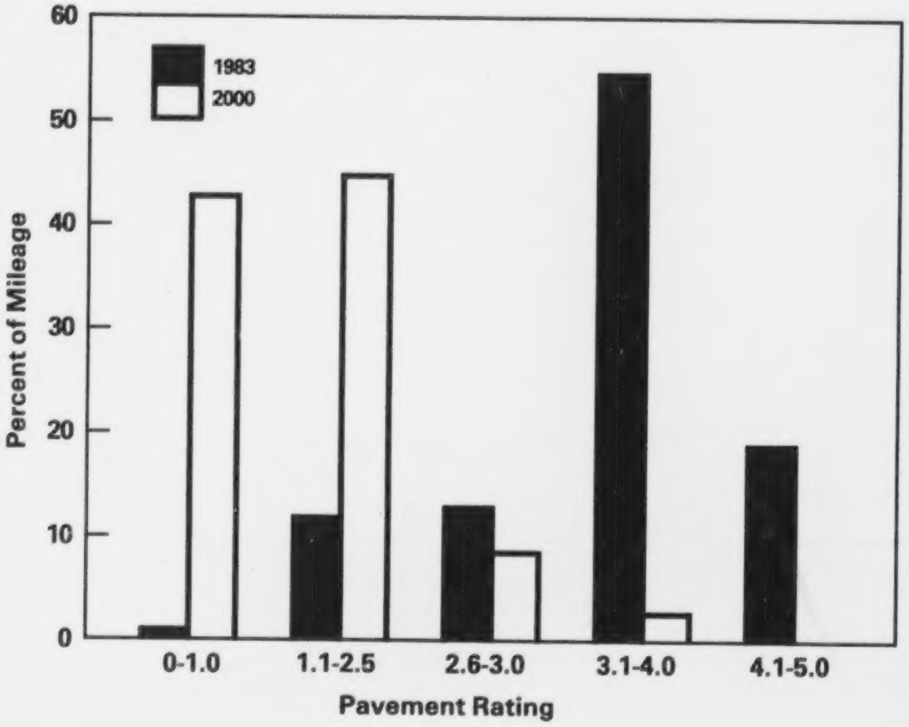


Figure IV-2

Urban Interstate Pavement Condition

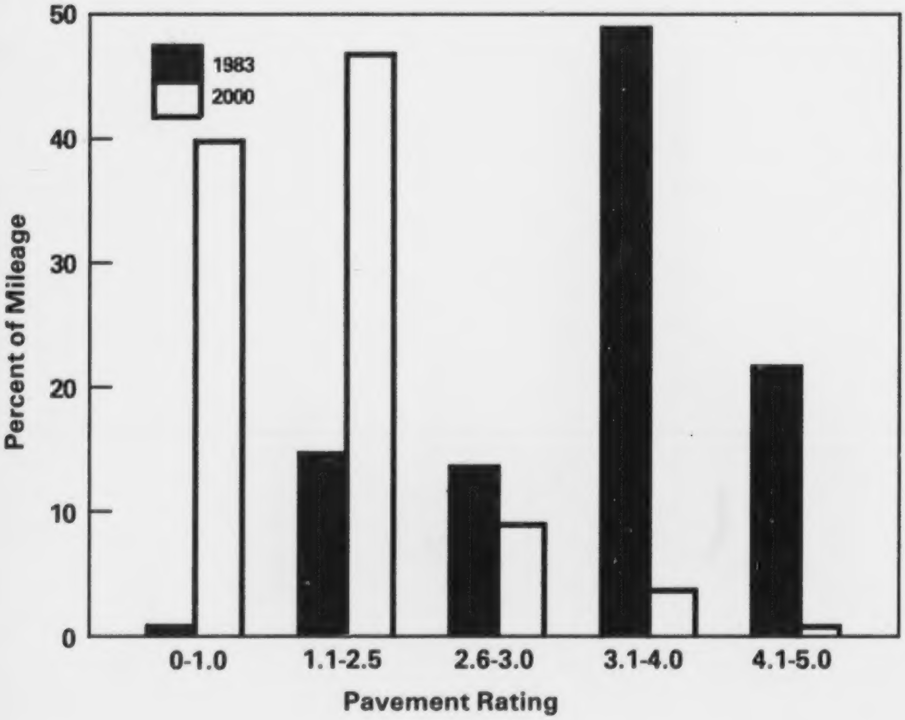


Figure IV-3

Rural Arterials
Pavement Condition

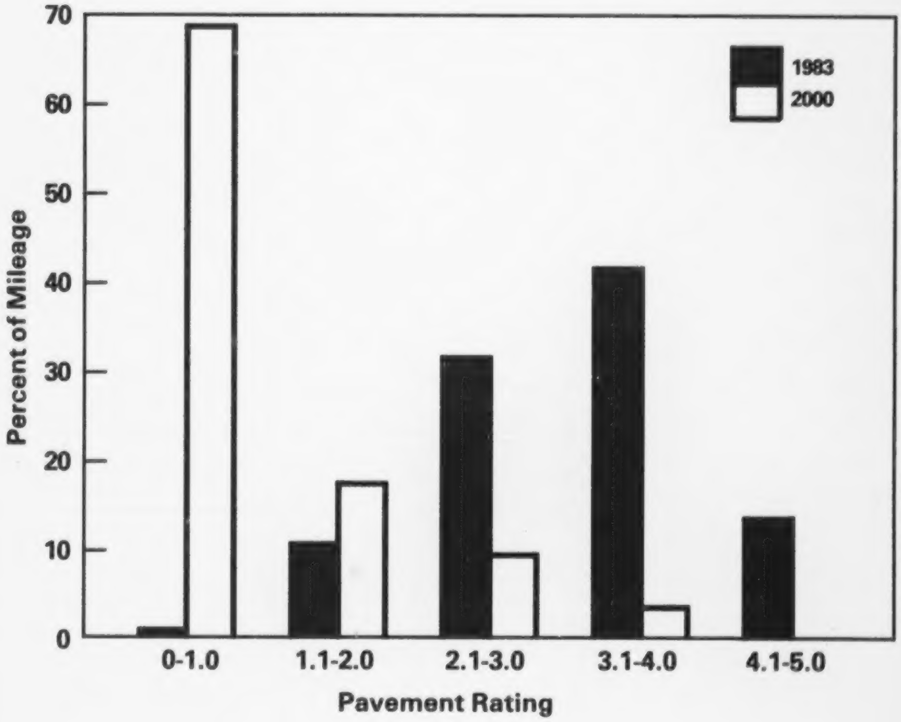


Figure IV-4

Urban Arterials Pavement Condition

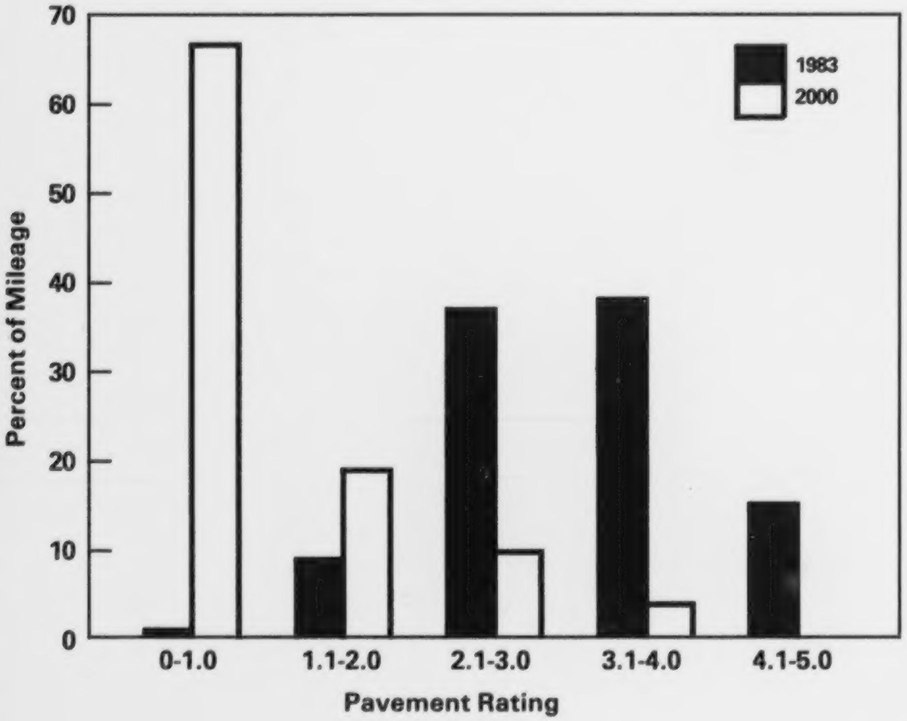


Figure IV-5

Rural Collectors
Pavement Condition

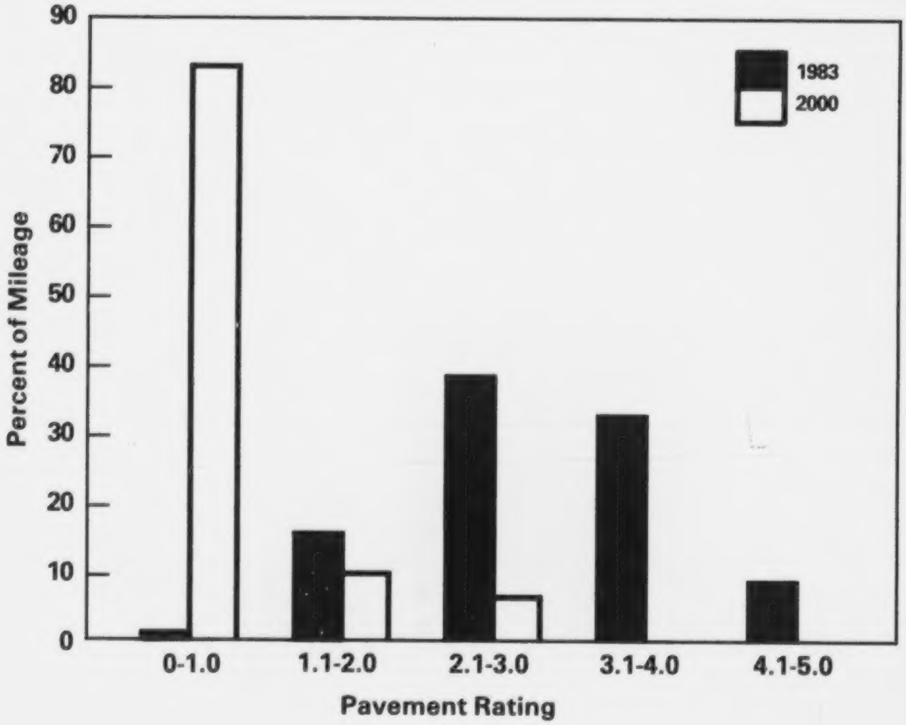


Figure IV-6

Urban Collectors Pavement Condition

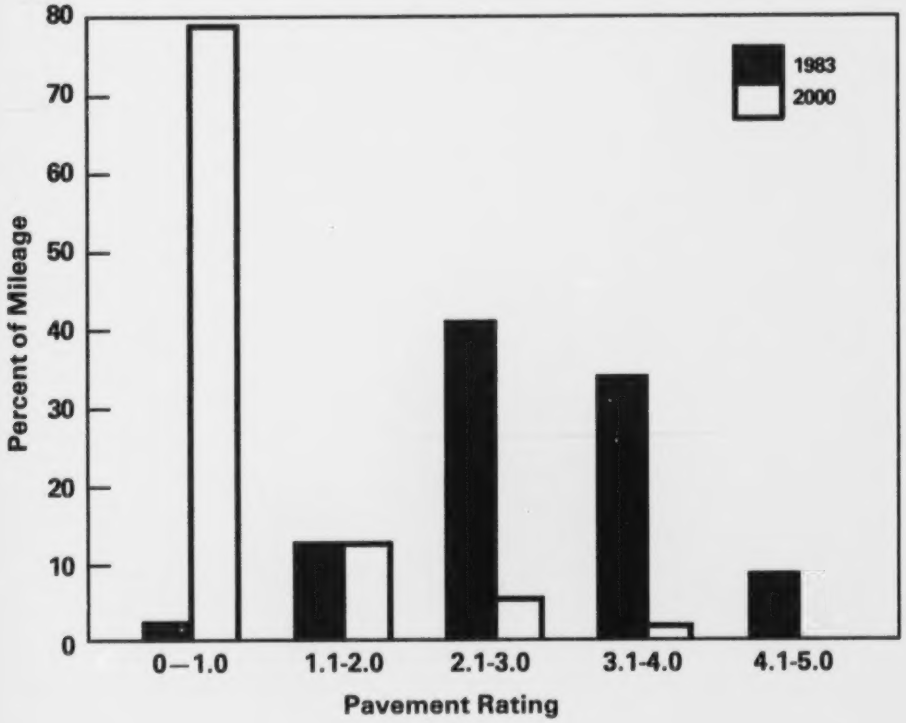


Figure IV-7

Investment/Performance Relationships (Theoretical)

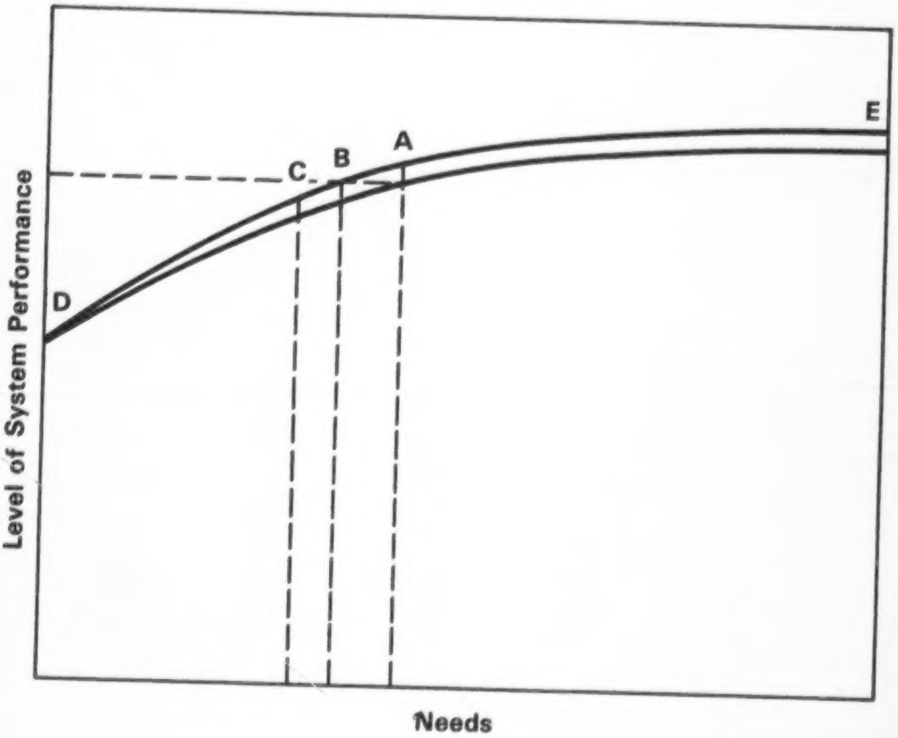


Figure IV-8

Rural Principal Arterials
PSR-Cost to Maintain

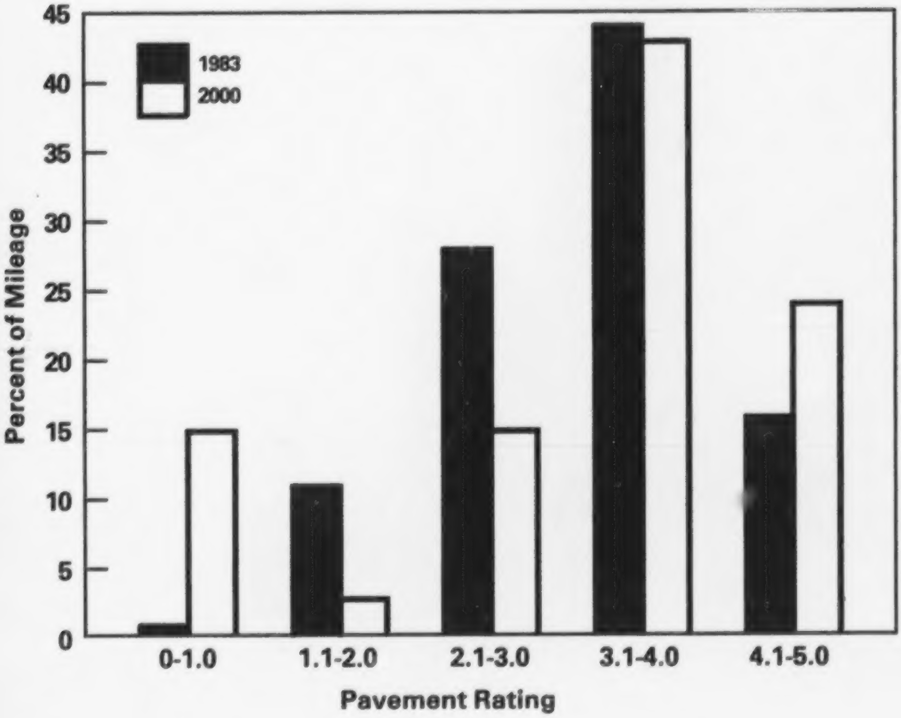


Figure IV-9

Urban Collectors PSR-Cost to Maintain

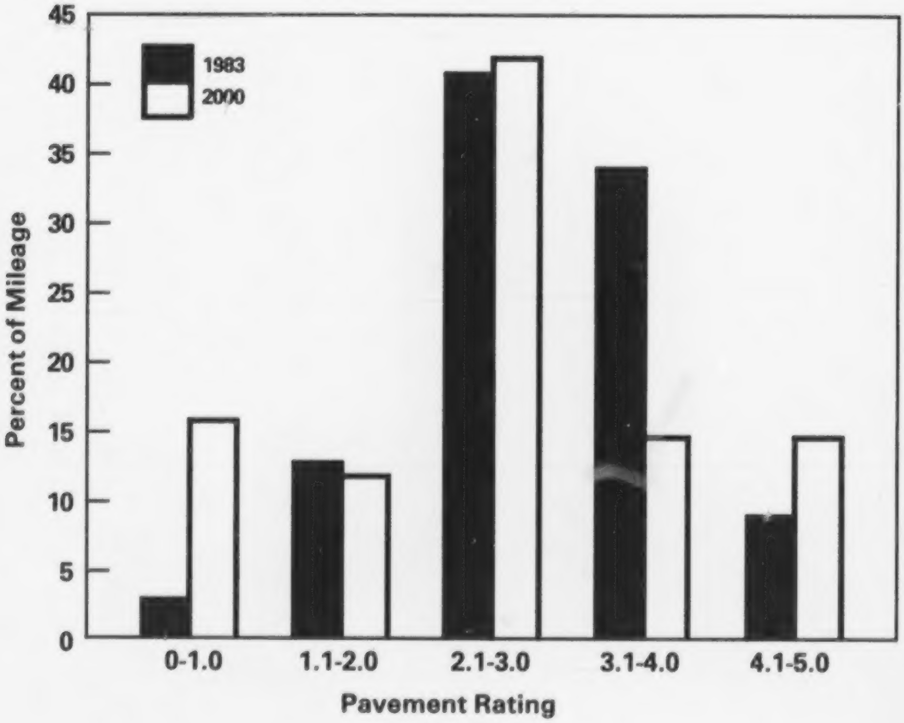


Figure IV-10

Investment/Performance - Interstate
1983-2000

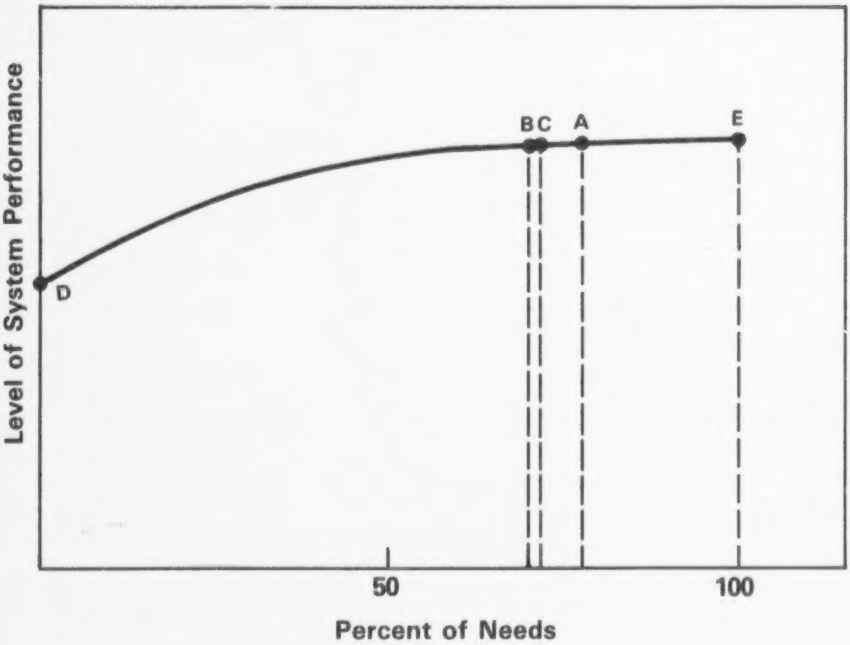


Figure IV-11

Investment/Performance - Arterials 1983-2000

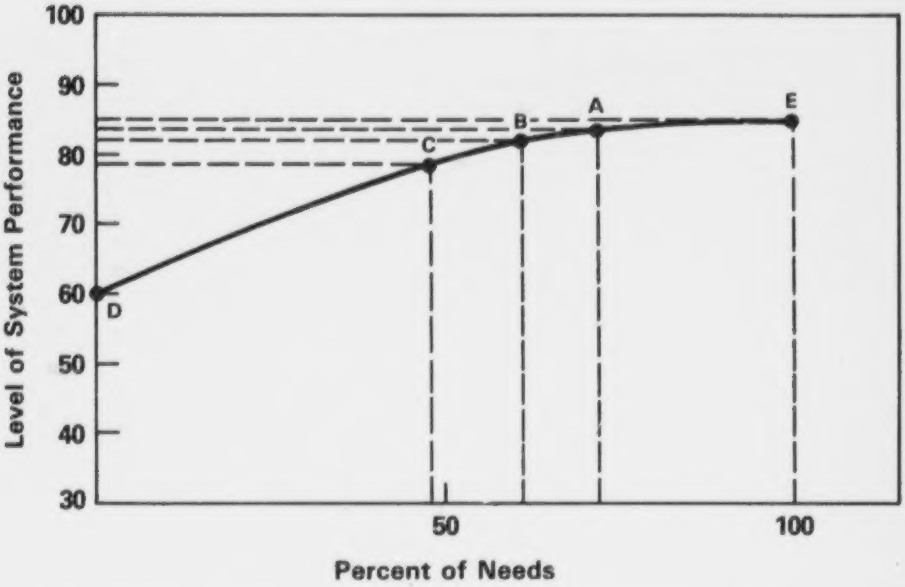
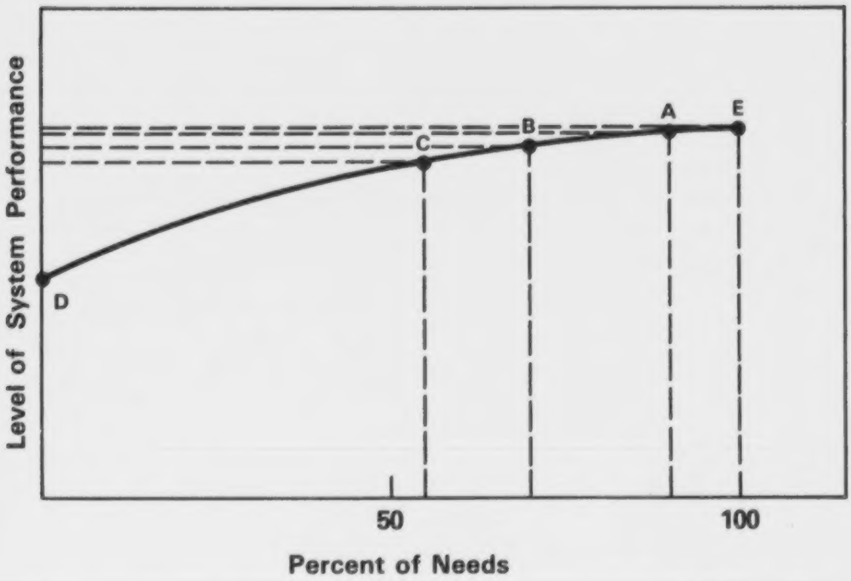


Figure IV-12

Investment/Performance - Arterials
1983-2000



CHAPTER V
THE FEDERAL-AID SYSTEMS

Chapters III and IV described the conditions and needs on the Nation's highways by functional system. This chapter summarizes similar information by Federal-aid system. Federal-aid systems are a subset of the Nation's highway network. They are administratively and functionally defined to meet varying State and Federal responsibilities, including interstate and interregional transportation, defense needs, urban mobility, and farm-to-market access.

Tables III-4 and 6 indicate the extent of the Federal-aid systems and their place within the hierarchy of the functional systems. Of the 1.2 million miles of nonlocal road in the United States, almost 835,000 miles are on one of the four Federal-aid systems, Interstate, primary, secondary, or urban. This is 70 percent of nonlocal mileage and 22 percent of all road mileage.

In 1983, the Federal-aid systems carried over 1.3 trillion VMT, 93 percent of highway travel occurring on nonlocal roads and 80 percent of all highway travel. The demand for service on Federal-aid highways is generally higher than on other roads.

In this chapter, as in the rest of the report, systems are discussed in the aggregate. Although condition data are made available at the State level, variations are normalized to provide an overall description of conditions and needs. Individual State or regional conditions and needs may vary significantly, depending on travel patterns, climatic factors, and State programs.

The needs estimates for each system are based on the cost-to-maintain 1983 conditions, Tables IV-4, 5, and 6, assuming a future travel growth of 2.74 percent annually. This is consistent with Federal-aid systems estimates included in the last report. Table I-2 shows capital needs to maintain 1983 physical conditions on the primary, secondary, and urban systems and full 4R needs on the Interstate. As in the previous chapter, this chapter addresses needs without regard for jurisdictional responsibilities.

THE INTERSTATE SYSTEM

Description

On June 29, 1956, President Dwight Eisenhower signed into law the 1956 Federal-Aid Highway Act which marked the beginning of the Interstate highway program as we now know it. The intent was to develop a system of limited access highways constructed to uniform design standards, linking metropolitan areas and industrial centers of 50,000 or more population. The System was designed to meet Federal interests in national defense and interstate commerce, and was to connect at suitable border points with routes of continental importance in Canada and Mexico.

The System was originally expected to cost $27 billion in 1956 dollars and was to be completed simultaneously in all the States. The System is now 97 percent complete, though some important intercity gaps remain to be built, and many portions of the System open to traffic still need improvements. These range from major improvements such as control of access and construction of additional lanes, to minor work, such as signing and other final phases of completion.

The Federal share of eligible Interstate project costs is 90 percent, except in States containing large areas of public lands, in which case the Federal share may be higher. Funds are authorized to be apportioned annually to States based on their relative share of the estimated cost necessary to complete the Interstate System.

Recent priorities for the Interstate System stress expedited completion and preservation of System conditions. The cost-to-complete the System was reduced by nearly $14 billion by the provisions of the Federal-Aid Highway Act of 1981, which limited costs "... to the construction necessary to provide a minimum level of acceptable service on the Interstate System which shall consist of: (1) full access control; (2) a pavement design to accommodate the types and volumes of traffic anticipated for the 20-year period from date of authorization of the initial basic construction contract; (3) essential environmental requirements . . . ."

The preservation of the System was established as a national priority in 1976 with the creation of the 3R program which provided for resurfacing, restoration and rehabilitation. Preservation was further advanced as a national priority in the 1981 Act, which nearly tripled authorizations, and established reconstruction as the fourth R.

Condition and Performance

In 1983, there were approximately 43,000 miles of Interstate, of which three quarters were in rural areas. Since 1978, 2,800 miles of new highways have been added to the System. In rural areas, the average daily vehicle count in 1983 was 12,000 per mile, unchanged from 1978. In urban areas, the average count per mile was 51,000, up 6.5 percent from 1978. Rural DVMT per mile has remained stable primarily because heavily used rural sections around urban areas eventually are reclassified as urban sections.

Although 2,800 miles of new Interstate highway were added between 1978 and 1983, pavement condition declined. Miles of highway with a PSR of 2.5 or less increased nearly 50 percent since 1978, from 4,100 miles in 1978 to 6,100 in 1983. Although 1,200 of these increased miles were in rural areas, the 800 in urban areas represented a much higher share of urban Interstate mileage than the 1,200 miles of rural Interstate mileage. At the same time, pavement in new or nearly new condition (PSR greater or equal to 4.0) declined 3,200 miles, or 20 percent. Most of the deterioration in pavement condition took place between 1978 and 1982. In 1983, approximately 3 percent of the mileage deteriorated while 2.7 percent of the pavement was resurfaced or reconstructed (see page 48). In general, Interstate pavement was in better condition than the rest of the Federal-aid systems because it was newer. However, the heavy traffic loads carried by this system caused more rapid deterioration to take place.

Interstate System highways had the lowest accident and fatality rates of all Federal-aid highway systems in 1983, reflecting the high design standards characteristic of both the rural and urban segments of this system (See Figures III- 8 and III-9). The absence of cross traffic conflicts and the presence of median separation, 12 feet travel lanes and safety features such as breakaway signing and obstacle-free zones adjacent to the roadway made the Interstate one of the safest highway systems in the world, in spite of the high traffic volumes.

Travel on the Interstate System grew 11 percent from 1978 through 1983, from 303 billion VMT to 336 billion VMT. Total travel on all highways during this period, which was impacted dramatically by the 1979 oil crisis, grew only 5.4 percent. Although 2,800 new highway miles were added to the Interstate during the 1978-1983 period, congestion levels rose on both rural and urban segments. In 1983, over 50 percent of all peak-period travel on urban Interstate facilities occurred under congested conditions.

As a result of declining pavement condition and increases in travel and traffic congestion, overall user costs on a unit basis rose approximately 5 percent between 1980 and 1983. However, preliminary information indicates that increased capital improvements, resulting from higher levels of Federal I-4R program funding, will mitigate further declines in Interstate System performance.

Interstate 4R Needs

Initially, all responsibility for Interstate System maintenance was placed with the States. This policy was altered in 1976 with the enactment of a 3R (resurfacing, restoration, and rehabilitation) program, separately authorized from the Interstate completion program. Since enactment, other elements of highway legislation have reinforced the Federal commitment to the preservation of the Interstate System, either through increased authorizations, increased Federal share, or expanded eligibility. The FY 1985 authorization for what is now termed the 4R program (3R plus reconstruction) is $2.8 billion, compared to the 1976 level of $175 million.

Between 1983 and the year 2000, virtually all of the Interstate System will require some form of capital investment to maintain serviceability. The cost of eliminating all deficiencies through the year 2000 varies from $61.8 to $54.3 billion, depending on level of travel. The cost to maintain 1983 conditions on the current System varies from $55 to $49.5 billion, again depending on travel. These estimates do not include certain 4th R items or overlaps with the Interstate Cost Estimate, which result in a total 4R estimate of from $64.3 billion to $56.3 billion, depending on future travel. In addition, the cost of repairing deficient Interstate bridges is $2.1 billion plus $8.5 billion for deficiences not eligible for the Highway Bridge Replacement and Rehabilitation Program. Needs on the System, however, may change as Congress redefines eligibility or otherwise changes the scope of the Interstate program

Interstate bridge needs of $10.6 billion include $2.1 billion that are identified in the fifth annual report to Congress on The Highway Bridge Replacement and Rehabilitation Program (HBRRP), plus $8.5 billion in existing bridge needs that are not eligible for HBRRP funding. The estimate of $8.5 billion in bridge needs was developed from information contained in the current National Bridge Inventory (NBI). The following is a summary of the improvement categories included in the latter estimate:

1.	Bridge Decks - Bridge deck needs were taken directly from the June 1984 NBI data (Item 58) and were calculated independently of any other data.	$5.2 billion
2.	Traffic Safety Features - Item 36 in the NBI manual includes bridge rails, transitions, approach guardrails, and approach rail ends. The June 1984 NBI data identified deficiencies in this category. This item does not contribute toward the deficient classification and was calculated independently of all other data.	$.9 billion

3.	Bridges rated less than 15 tons.	$.4 billion
4.	Vertical clearance less than 14 feet-00 inches.	$.1 billion
5.	Vertical clearance 14 feet-00 inches to 15 feet-11 inches.	$.2 billion
6.	Other deficiencies - This includes deficiencies such as waterway adequacy, deck geometry, and structural condition etc., on structures with a sufficiency rating greater than 80, thus making them ineligible for HBRRP funding.	$1.7 billion
	Total	$8.5 billion

THE PRIMARY SYSTEM

Description

The primary system is the original Federal-aid system, dating back to the Federal Highway Act of 1921. Provisions in the Act required that Federal-aid funds not only be spent on a designated system of interconnected roads, but also required that States designate these systems. Haphazard road development was avoided by giving preference to projects, among the candidates for Federal aid, that would complete an adequate and connected system of interstate highways.

Originally this system was not to exceed 7 percent of the total highway mileage for each State. When the Interstate was designated it was incorporated into the primary system as a subset. Congress realigned the primary system in 1976 to better reflect that interstate function.

Today the primary system consists of connected main highways important to interstate, statewide, and regional travel, consisting of approximately 256,000 miles, excluding the Interstate. Rural routes account for 227,000 miles (89 percent) with 28,600 miles (11 percent) of primary urban extensions.

Virtually all rural arterials and 30 percent of the urban arterials are on the primary system. The system links the Nation's cities and larger towns and farms in an integrated network that provides interstate and intercounty service. All urbanized areas (50,000 and over) and nearly all areas with populations of at least 25,000 are served by the system. Its importance is underscored by the fact that half of all highway travel in 1980 occurred on the primary system (including the Interstate System).

In rural areas, the typical primary route is a two-lane highway with high-type pavement, lane widths of 11 feet or greater and shoulders of adequate width. The average route carries about 2,500 vehicles a day, with the percentage of trucks ranging from 10 to 30 percent.

In urban areas, the typical route expands to four to six lanes of high-type pavement that are undivided and without access control. The travel lanes are 12 feet wide with curbs in built-up areas and adequate paved shoulders in the outlying sections. Average daily volume is approximately 20,000 vehicles. During daily peak-travel periods the typical primary route is operating at full capacity.

Condition and Performance (Excludes Interstate)

The typical route on the primary system has been built to a high standard and remains in good condition. Very little change took place in the percent of pavement needing repair or resurfacing between 1978 and 1983. During that period, there also was a reduction in the percent of pavement that had reached a stage where rapid deterioration was occurring. In 1983, a substantial increase in pavement resurfacing and replacement activity helped reverse a short-term trend toward a deterioration of overall pavement condition. This was especially true on rural primary routes.

Fatality rates on the primary system were generally higher than on the Interstate, but were below rates on collectors. Although less than 10 percent of primary mileage had some degree of access control, the abundance of mileage with wide travel lanes, paved shoulders and adequate passing sight distance helped reduce accident potential on this system, even though a large percentage of the miles were heavily traveled.

The percent of travel experiencing congestion during peak travel periods increased steadily between 1975 and 1983, although congestion still was not a major problem on most of the system. Overall, a higher percentage of peak period travel experienced congestion on the primary system than on the rural Interstate.

Primary System Needs

Approximately 230,000 miles of the primary system will require capital investment through the year 2000. The cost of maintaining 1983 conditions varies by level of travel from $93.3 to $83.1 billion, or from $5.2 to $4.6 billion annually in real terms. This is approximately a $1.0 billion annual increase in real terms compared to the last report to Congress. This increase is attributable primarily to improvements to the analytical methodology described on page 86. The cost of repairing or replacing existing deficient primary system bridges is $10.2 billion.

THE URBAN SYSTEM

Description

The Federal-Aid Highway Act of 1970 established the urban system to meet the unique transportation needs of the urban areas. The urban system consists of arterial and collector routes. It serves the heaviest urban population corridors in areas with populations of 5,000 or more, and major activity centers to aid in intracity movement. No route on the urban system is on another Federal-aid system, and each route connects with another route of the urban system or one of the other Federal-aid systems. The system is selected cooperatively by the appropriate local officials and the State highway departments. The system carries 44 percent of urban travel on 7 percent of all urban mileage.

The Federal share of eligible projects is 75 percent except in States containing large areas of public lands, where it may be higher. Authorized funds are annually apportioned to States based on their relative urban (defined as 5,000 or greater) population. No State receives less than one-half percent of the total.

Two-thirds of all nonlocal urban highway and street mileage is on the urban system. Minor arterials account for 44 percent of the system mileage, while collectors account for 39 percent. Principal arterials account for the remaining 17 percent, only 650 miles of which are expressways.

The majority (64 percent) of the mileage is in outlying sections of the urban areas, but travel on the system is divided evenly between center city and outlying areas. The typical urban system section is a two-lane undivided roadway with 12-foot lanes. In the more developed sections of the urban area, the route has curbs instead of shoulders, typical of a city street. In the outlying areas, the roadway has a rural cross section (no curb and gutter) with some sort of stabilizing treatment on 6-foot wide shoulders. The roadway has a high-type asphalt or concrete pavement and carries about 5,000 vehicles per day. The section is generally speed controlled at 35 m.p.h.

Condition and Performance

Pavement condition on routes on the Federal-Aid Urban System (FAUS) is typical of urban minor arterials and collectors. In 1983, 12 percent of the system pavement had a PSR of 2.0 or lower with collector routes generally having more poor pavement than the arterials.

In general, FAUS routes had low fatality rates and low levels of peak-period congestion, when compared to urban Interstate and primary sections. Between 1980 and 1983, user costs per mile of travel dropped slightly reflecting small decreases in congestion on both the arterial and collector segments of FAUS.

Urban System Needs

Through the end of the century, over 95 percent of all urban system mileage will require capital investment to maintain serviceability. High levels of congestion will influence this situation to a greater degree relative to pavement inadequacies than on other Federal-aid systems. The urban system provides more peak-period service and alternative routes than do comparable roads in a rural setting, hence, the greater degree of influence of congestion. Further, almost 40 percent of urban system mileage cannot be feasibly widened beyond two lanes to accommodate increased congestion. Transit, paratransit, and auto use management strategies remain the most likely steps that may feasibly be taken to reduce future growth in congestion. This is particularly true as urban functions and travel patterns move further into suburbs and lateral type travel from suburb to suburb increases compared to the more traditional radial patterns between central cities and suburbs.

Investment needs on the urban system vary from $72.7 to $67 billion in 1983 dollars, or from $4.0 to $3.7 billion annually through the year 2000. Although this level of investment will maintain overall 1983 conditions, congestion will increase on substantial portions of the system because of the right-of-way constraints mentioned earlier. Bridge needs on the urban system are an additional $5.3 billion.

THE SECONDARY SYSTEM

Description

The secondary program was established in 1944. The secondary system originally consisted of farm-to-market routes, but because of very loosely defined criteria, it eventually included every type of rural road from the local access road to the highest order arterial.

In 1976, the system was realigned by direction of Congress so that only roads that functionally served as major rural collector routes would be eligible for inclusion on the system. Today the system includes over 397,000 of the 434,000 miles (91 percent) of the major rural collectors in the country. These routes, unlike the primary system, do not form an interconnected network of highways. Instead they are, as their functional title implies, collectors of travel funneling onto and off the State arterial network.

Today the secondary system serves three major activities. First, the routes provide service to county seats not on an arterial route and to other traffic generators of equivalent intracounty importance, such as mining or agricultural areas, shipping points, etc. Second, they link major county traffic generators with nearby larger towns or cities. Finally, they serve the more important intracounty travel corridors and connect with routes of higher classifications within the county.

The roads on the secondary system comprise 12 percent of all rural mileage and carry 21 percent of rural travel. Typically, the secondary route (secondary system routes vary considerably by individual State and region of the country) is a two-lane rural road paved with an intermediate type of surface treatment not designed to carry very heavy axle loads. The pavement itself is in fair condition. Each lane is 10 feet wide, and 4-foot wide earth shoulders complete the roadway cross section. The horizontal and vertical alignment of the roadway is adequate for the approximately 1,000-vehicle-per-day density of usage. One bridge in three has some deficiency.

Condition and Performance

Eighty-seven percent of the Federal-aid secondary (FAS) mileage was paved, and over 16 percent of the paved miles needed resurfacing or pavement replacement in 1983, a figure that has varied very little since 1978.

Over 80 percent of the FAS system had at least one condition or design problem and 40 percent had 2 or more. Most of these problems related either to poor pavement or lower types of pavement, inadequate roadway cross-section features such as narrow lane widths or unpaved shoulders, or inadequate passing sight distances for the volume of traffic using the facility. Congestion was rarely a problem on this system -- the average daily travel was under 1,000 vehicles per day.

Although the typical FAS route is lightly traveled, fatality rates have consistently been higher than on any other Federal-aid system. This is caused, in part, by the lower design features and the large number of cross-traffic conflicts.

Secondary System Needs

The cost to maintain overall conditions on the secondary system ranges from $46.6 to $41.7 billion, or from $2.6 to $2.3 billion annually through the year 2000. This is lower than reported in 1983, almost exclusively because of changes in the methodology described on page 86. Bridge needs on the secondary system are an additional $6.6 billion.

CHAPTER VI

DEMOGRAPHICS, ECONOMICS, AND HIGHWAY TRAVEL

The purpose of this report, as described in the introduction, is to illuminate the development and evaluation of policy and program options, through the appraisal of various facets of the Nation's highway program, including finance, condition, and future needs. Chapters IV and V quantified future needs at the national level by using existing highway conditions and estimating the effects of a range of future travel on the condition and performance of each system. Those estimates were provided by functional and administrative system and by type of development, urban or rural. Nationwide estimation, in and of itself, is sufficient to meet the requirements of Congress regarding highway needs reporting.

The purpose of this chapter is to suggest emerging program and policy issues by providing a greater level of detail concerning future travel and the determinants which are used to forecast travel. Included is an overview of each determinant, a discussion of how the determinant affects highway travel and how each determinant has changed in the decade 1970 through 1980. Also included is a discussion of how each determinant is likely to affect highway travel in the future. The effect of the determinants on travel in urbanized areas is of particular concern due to the rapid growth of suburbanization during the decade of the seventies. This concern is discussed to highlight the potential problem in urbanized areas associated with changing demographic patterns. This chapter describes likely demographic and economic scenarios; it does not suggest policies or programs to meet changing travel demands.

This chapter focuses on the period from 1980 to 2000. The 1980 base year was chosen because it reflects the most recent decennial census. The year 2000 was chosen, among other reasons, because various demographic and economic forecasts from the Department of Commerce, Bureaus of the Census and Economic Analysis are available for that year and their forecasts are used extensively in developing travel estimates. The multistate regions referred to throughout this chapter are depicted in Figure VI-1.

Travel is a derived demand, that is, the amount of travel is a function of other activities rather than an end in itself. These other activities, which we have categorized below as demographic, economic, and other factors, influence travel in a complex, often interrelated fashion. Although the indicators discussed in this chapter are independently measurable, they are not additive because of this complexity and interrelationship.

DEMOGRAPHIC FACTORS

Population Size

All things being equal, there is a direct and positive relationship between population and travel. During the 1970's the Nation's population grew from 203.3 million to 226.5 million, an increase of 11.4 percent (Figure VI-2). For the first time in many decades, rural and urban populations grew at similar rates: the rural population grew 10.5 percent, the urban, 11.8 percent.

For the year 2000, the Bureau of the Census projects an 18.1-percent increase in population between 1980 and the year 2000. This is a year 2000 population of 267.5 million. Drastic changes in birth, death or migration rates would affect this figure.

Population Location

In addition to population size, population location affects the location of travel. For example, people living in rural or suburban areas drive more than those in urban areas. People in larger cities generally drive more than those in smaller cities except in the largest urban areas. People in southern and western cities, which are usually spread out and lack efficient mass transportation, drive more than people in northeastern cities.

Regional populations changed at different rates. Figure VI-3 shows the 1970 and 1980 regional population and the year 2000 regional forecast. The forecasts show the 1970 to 1980 trend continuing whereby Southern and Western States gain population and Northeastern States stabilize.

Population location changed within urban areas. During the 1970's, there was a steady shift in population away from large cities. In 1970, 29.7 percent of the population lived in cities larger than 500,000. In 1980, only 25.3 percent did. Most people who leave the city move to the suburbs, with its higher travel tendencies. In 1970, there were 27 urbanized areas with central cities with populations of 500,000 or more. The total population of these areas was 71.3 million. Of this, 35.4 million lived in the central cities and 35.9 million in the outlying areas, but within the urbanized area. In 1980, these same areas had a total population of 75.5 million but the shift to outside the central cities was dramatic: 32.4 million in the central cities, 43.1 million in the area outside the central cities. These central cities lost 8.68 percent of their population while the outlying areas increased by 20.1 percent. Nationwide, central cities of all urbanized areas grew by 3 percent and outlying areas grew by 29.6 percent. Figure VI-4 shows the growth rate from 1970 to 1980 of all urbanized areas by region, separated by central city and outside central city growth. Figure VI-5 shows the total population by region in 1970 and 1980 for urbanized area central city and outside central cities. The two figures illustrate that the population location trend in the urbanized area is to the suburban locations. Data on growth in the area immediately outside the urbanized area is not readily available for analysis. For the future, Figures VI-6 and VI-7 show urban and rural population by region for 1980 and 2000. Rural population is expected to expand greatly in some areas and remain constant in others. Urban population will increase almost 21 percent, growing in all regions except the mideast, Great Lakes and Alaska-Hawaii.

The net effect is that VMT will increase. This is due to the increase in population, the movement of population to southern and western areas, and the continued trend toward suburbanization in all parts of the country.

Age Distribution

Figure VI-8 illustrates how travel characteristics vary with age. Highway travel peaks in the 35-49 age group, so a major change in the size of this age group would likely indicate a major change in VMT. During the 1970's the median age of Americans increased from 28 to 30 years. The number of people of driving age increased 21.5 percent, from 141 million 16 and older in 1970 to 172 million in 1980. The biggest gain was in the 22 to 34 age group, 42.9 percent. The jump in VMT from 1970 to 1980 can partly be explained from the fact that this group has the second highest per capita VMT.

For the future, Figure VI-9 gives a breakdown of population by age group for years 1970, 1980 and 2000. The largest projected increase is in the 35 to 49 age group, which has the highest VMT per capita. This is the babyboom generation entering prime driving years. The percentage of people of driving age will increase from 72.4 percent to 75.0 percent. Thus, not only will the population be greater in the year 2000, but it will be concentrated in age groups with high VMT per capita tendencies.

Household Distribution

The Bureau of the Census defines a household as all persons occupying a single housing unit. Figure VI-10 illustrates that as the size of a household increases, the number of trips per person decreases.

In 1970, the average household contained 3.11 people. By 1980 the average was just 2.75 people. The only region in 1980 with a substantially different size of household was Alaska-Hawaii, which had 3.09 people per household. Among individual States there was more variation: Utah had 3.20 persons per households, the District of Columbia, 2.39. In urbanized areas, the average household size changed from 3.2 in 1970 to 2.74 in 1980.

As a result of several causal factors, nationwide, there was an approximate 2-percent increase in trips per person.

This downward trend in the size of households is expected to continue through the end of the century. In the year 2000 the average household will contain 2.35 people, down from 2.75 in 1980. Accordingly there will be about 1.7 percent more trips daily per person, with a similar increase in VMT.

ECONOMIC FACTORS

The overall state of the economy, and individual economic factors, influence how often and how far people drive. During periods of economic expansion travel increases, during recessions it decreases. Figure VI-11 shows the historic relationship between travel and the economy, as measured by the Gross National Product (GNP).

Size and Type of Workforce

The first economic consideration is the size of the work force. People who work drive more than people who do not. As new jobs are created, additional VMT may be expected. Also important is what jobs people are holding because travel changes depending on occupation. Therefore, one of the necessary steps in forecasting VMT is predicting how many people will be working and what jobs they will be performing. If this is not done, such factors as women entering the workforce and the relative decline of heavy industry employment may not be adequately considered in the forecast.

During the 1970's, total civilian employment increased 26.2 percent from 78.7 million to 99.3 million people. Much of this increase was women entering the work force. In 1970, 29.7 million women were working; in 1980, 42.1 million were working, or 60.1 percent of the total increase in the workforce. There was also a shift in the types of jobs held. Employment in trade and services increased dramatically while manufacturing employment was relatively stable and agricultural employment declined. These results are summarized in Figure VI-12.

The labor force is expected to grow from 99.3 million in 1980 to 130.9 million in the year 2000, an increase of 31.9 percent. The percentage of women in the labor force will continue to grow, representing a 45.7 percent share of the year 2000 labor force.

The trends in industrial mix established in the 1970's are also expected to continue. Trade and services and government will grow the fastest. Agriculture will continue to decline. These trends are summarized in Figure VI-12.

Income

Income also affects driving habits. Generally, higher income denotes more travel. The same is true for households, as illustrated in Figure VI-13. We may reasonably infer that if real income per capita rises VMT per capita also will rise.

The best measure of personal income for forecasting VMT is Disposable Personal Income (DPI) per capita, or after-tax income. Measured in 1980 dollars, this figure rose from $6,558 per person in 1970 to $8,004 in 1980. This helps explain the increase in VMT in the 1970's--people had more money with which to buy, drive, and maintain their cars. This trend is show in Figure VI-14.

Nationally, disposable real income per capita is forecast to rise 73 percent from 1980 to 2000. The anticipated regional distribution of this increase is shown in Figure VI-15. The biggest gains will be in the Southeast and the Plains, the regions that currently have the lowest and third lowest personal incomes respectively.

To put these figures in perspective, in the 1970's DPI per capita grew 22.0 percent while VMT grew 36.5 percent. While it is unlikely that VMT will continue to grow so quickly compared to personal income, it seems likely that VMT will increase dramatically by the end of the century, particularly in the south, midwest, and west.

Industrial Income

Industries also alter their driving patterns according to income. The best measure of industrial income is Labor and Proprietors Income (LPI). In general, the higher a region's LPI the greater its VMT. This data must be analyzed carefully, however; shifts in LPI among industries can alter traffic patterns. For example, construction creates far more truck VMT than does manufacturing, so a shift in LPI from manufacturing to construction would create additional VMT.

The Nation's LPI grew 29.2 percent in the 1970's. Although all regions experienced increases, the rates varied tremendously, as shown in Figure VI-16. The southwest experienced the largest increase, 69.8 percent, while the mideast had a mere 11.2 percent increase. The regions where VMT grew the fastest are the same ones that had large LPI growth.

The LPI is expected to grow faster than DPI. In fact, LPI is predicted to more than double by the end of the century, increasing 114.7 percent over 1980's. As with DPI, the increase will vary widely among regions. The biggest gainer will be the Rocky Mountains region with a gain of 211.5 percent, the smallest, the Mideast with a gain of 63.1 percent. As with DPI, these predictions indicate a substantial VMT growth by the year 2000.

Motor Vehicle Fleet

Newer and larger cars are responsible for more VMT than older or smaller cars. Since higher income groups tend to buy larger cars and to buy cars more frequently, increase in per capita income should cause additional VMT.

During the 1970's, the number of registered automobiles increased from 89.2 million to 121.7 million. This increase is shown on a regional basis in Figure VI-17. Truck ownership increased more dramatically. In 1970 there were 18.8 million registered trucks, in 1980, 33.6 million. Vehicle ownership in urbanized areas has also shown a substantial increase from 1970 to 1980. In 1970, urbanized areas had .38 vehicles per person. In 1980, the rate was .48 per person, an increase of 25 percent in the auto ownership rate.

One reason for the increase in the number of motor vehicles was that people were keeping vehicles longer. In 1970, the median age of cars was 4.9 years, in 1980, 6.0 years. Figure VI-18 gives a breakdown by age group of passenger cars in 1970 and 1980. Trucks also posted an increase in median age, from 5.9 years in 1970, to 6.3 years in 1980.

The average size of trucks increased. As industries required more hauling capacity, they opted for larger rather than more trucks, because a fleet of large trucks can haul a given amount of freight more cheaply than a fleet of small trucks. This trend indicates that heavy truck VMT will grow more slowly than industrial production because fewer trucks will be needed to move a given amount of freight.

The number of cars on the road can be expected to continue increasing through the year 2000. It is unlikely that its growth rate will approach the 1970's. It is already approaching the saturation point of one car per person aged 16 or older. In 1980, there were 70.8 automobiles per 100 persons 16 and older. If this rate is maintained there will be about 142.1 million automobiles in the year 2000. This figure may be slightly low because a higher percentage of eligible people will be driving by the year 2000.

The trend towards smaller, more efficient cars is also likely to continue, in part because of government regulations requiring new car fleets to have a certain average mileage. The truck fleet will continue growing, though not as quickly as it did in the 1970's. Vans particularly will become more numerous. Among large trucks, the trend towards heavier trucks is expected to continue.

OTHER FACTORS

Three other factors which can affect VMT are safety, alternative modes and fuel availability.

Safety

People are less likely to drive if they do not feel safe while driving. Unfortunately, perceptions of safety and the actual safety record may differ. This limits safety's usefulness as a factor. Safety would only become a major factor if highways became far more dangerous than the current records indicate. As long as this doesn't happen, highway travel should not be affected; increased safety probably would not affect VMT.

Highway travel became safer in the 1970's. In 1970, there were 4.82 fatalities per 100 million VMT. By 1980, there were 3.36 (see Figure VI-19). Despite the increase in

VMT, the number of fatalities dropped, from 53,677 to 51,077. This decrease was caused by several factors including the national 55 m.p.h. speed limit, increased use of seatbelts and child restraints, and safer cars.

Forecasting highway safety is very difficult, but since the recent trend--indeed the trend for decades--has been towards safer highways, it is probable that driving will be even safer in the future. By 1982, the fatality rate was 2.75 per 100 million VMT, down 18.2 percent from 1980, and less than half the rate in 1966. Aside from this general trend, Federal and State interest in seat belt usage and other restraint systems should further influence the fatality rate.

Safety probably will not be a major determinant of future highway travel. Since highway travel is becoming safer, people will continue to drive as much as the other determinants dictate.

Alternative Modes

Airplanes, trains and ships compete with highway vehicles for passengers and freight. Transit systems compete with highway vehicles for intracity passengers. A switch to or away from one of these modes would affect highway travel.

During the 1970's, highway travel increased its share of the freight hauling market, but decreased in the passenger category. Figure VI-20 shows the percentage of passenger miles by mode of travel. The only mode that increased its share was air travel, which grew from 10.0 percent to 14.1 percent. Since air travel is all intercity, it competes only with intercity, not local, driving. Local driving is complemented by increased air travel because access to airports is almost always by car.

Figure VI-21 shows that trucks' share of the freight hauling market increased slightly. This implies that neither railroads nor ships nor pipelines are currently capable of eroding trucking's share of the freight market.

Highway travel's share of the passenger and freight markets is not expected to change drastically by the year 2000. The passenger market is already dominated by motor vehicles and it would take a large increase by another mode to substantially affect highway travel's share. Air travel is the only mode that will likely grow significantly. This means that intercity highway travel will probably grow more slowly than local travel.

Mass transportation should also be considered. Figure VI-22 shows use of public transportation by State. Most of the States with high usage rates are in the northeast. Therefore, as people move to southern and western cities, these public transportation systems will become less important. This will be countered somewhat by new mass transit systems being built in southern and western cities. Since mass transportation accounts for only a few percent of passenger-miles, it would take a large shift to or away from mass transportation to noticeably affect VMT.

Trucking will continue to be an important means of hauling freight. Its share of the market should stay about the same or increase slightly, chiefly because it has few competitors. Pipelines cannot be used to ship most things shipped by truck. Ships cannot be used for local travel or on many intercity routes. Only railroads offer much competition and then only on intercity routes. It is hard to project how viable they will be in the year 2000, but it is unlikely that they, or any other mode of hauling freight, will erode trucking's share of the market.

Fuel Availability

Since almost all highway vehicles use petroleum products for fuel, highway travel necessarily depends on the availability of fossil fuels. As the supply of motor fuel dwindles, prices will rise and travel will decline. While future fuel availability is difficult to predict--it involves political as well as technological questions--some account of the increasing price of fuel or availability should be taken when forecasting VMT.

Data from the 1970's show conclusively that highway travel and fuel availability are closely related. This does not mean, however, that fuel availability is a useful travel determinant. Such occurrences as the fuel crises of 1973 and 1979 cannot reasonably be taken into a VMT forecasting method; there is no way to predict them. Therefore, increasing fuel prices must be viewed on a long term rather than short term basis. It is impossible to say when the U.S. will experience another fuel crisis, but it is reasonable to predict what the price of gasoline will be in the year 2000 based on a yearly percentage increase. The annual growth rate to be applied is a matter of speculation. The rate for 1970 through 1980 was 12.5 percent per year. The rate for 1965 through 1983 was 7.9 percent per year. The future rate is likely to be somewhere in this range of values. If this is the case, Americans will continually become more aware of the cost of driving, and will probably alter their driving habits somewhat by reducing travel, sharing trips, or purchasing more fuel efficient vehicles.

SUMMARY

Figure VI-23 illustrates growth in VMT from 1965 to 1983. Observing this trend one concludes that VMT will continue to grow in the future. There will be aberrations in the growth rate, as there were in 1974 and 1980, but overall the trend will be upward. To go beyond this--to actually make accurate long range forecasts of highway travel--requires looking at more than simply past highway travel trends. One must look to see what forces have spurred travel growth in the past and predict whether they will do so in the future. One must also observe the factors that limit highway travel and decide whether they are minor detours or serious impediments. By using these determinants one can predict a growth or decline that would be missed by simple extrapolation of past highway travel data.

While travel is expected to increase nationwide, the increase will not be uniform. Some regions of the country will experience rapid growth in travel while other may experience a slight decline. Such disparities may also occur within regions.

The list of determinants in this chapter is by no means inclusive; it is not intended to be so. It does, however, include those factors thought to be most responsible for determining highway travel: population, its distribution and attributes; the economy; and other factors including highway safety, the availability of fuel, and alternatives to highway travel.

Highway travel increased 36.5 percent during the period 1970 to 1980. As illustrated by the the following table, it should continue to increase through the year 2000. Since the factors causing VMT to increase are interrelated, a close monitoring of them is vital to determine the exact extent to which VMT will increase.

The table below summarizes each factor, the recent trends and the expected future effect on travel:

Factor	Recent Trends	Expected Effect on Travel
Population size	Increasing	Will cause VMT increase.
Population location	Moving from northeast to south and southwest; moving from central city to suburbs.	Will cause VMT increases in growing areas.
Age distribution	Age group 35 to 49 will grow the most, primary driving age.	VMT will increase due to increase in driving age population.
Household distribution	Household size declining.	Smaller households have more VMT per person, VMT will increase.
Size and type of workforce	Size will increase due to population increase, entry of women into workforce.	People who work drive more than nonworkers. VMT will increase.
Personal income	Will increase to the year 2000.	VMT will increase due to increase in personal income.
Industrial income	Expected to increase.	Will cause VMT to increase, particularly in trucking.
Vehicle fleet	Will increase in size due to population increase. Will become older.	VMT will increase, but effect may be due to population and income changes, not vehicle fleet.
Safety	Safety will continue to increase.	Little or none
Alternate modes	Other modes will maintain their existing shares of freight and passenger travel.	Little or none
Fuel availability	Cost of driving will become more apparent, fuel availability difficult to forecast.	Increased fuel cost may limit VMT.

Figure VI-1

Bureau of Economic Analysis Regions

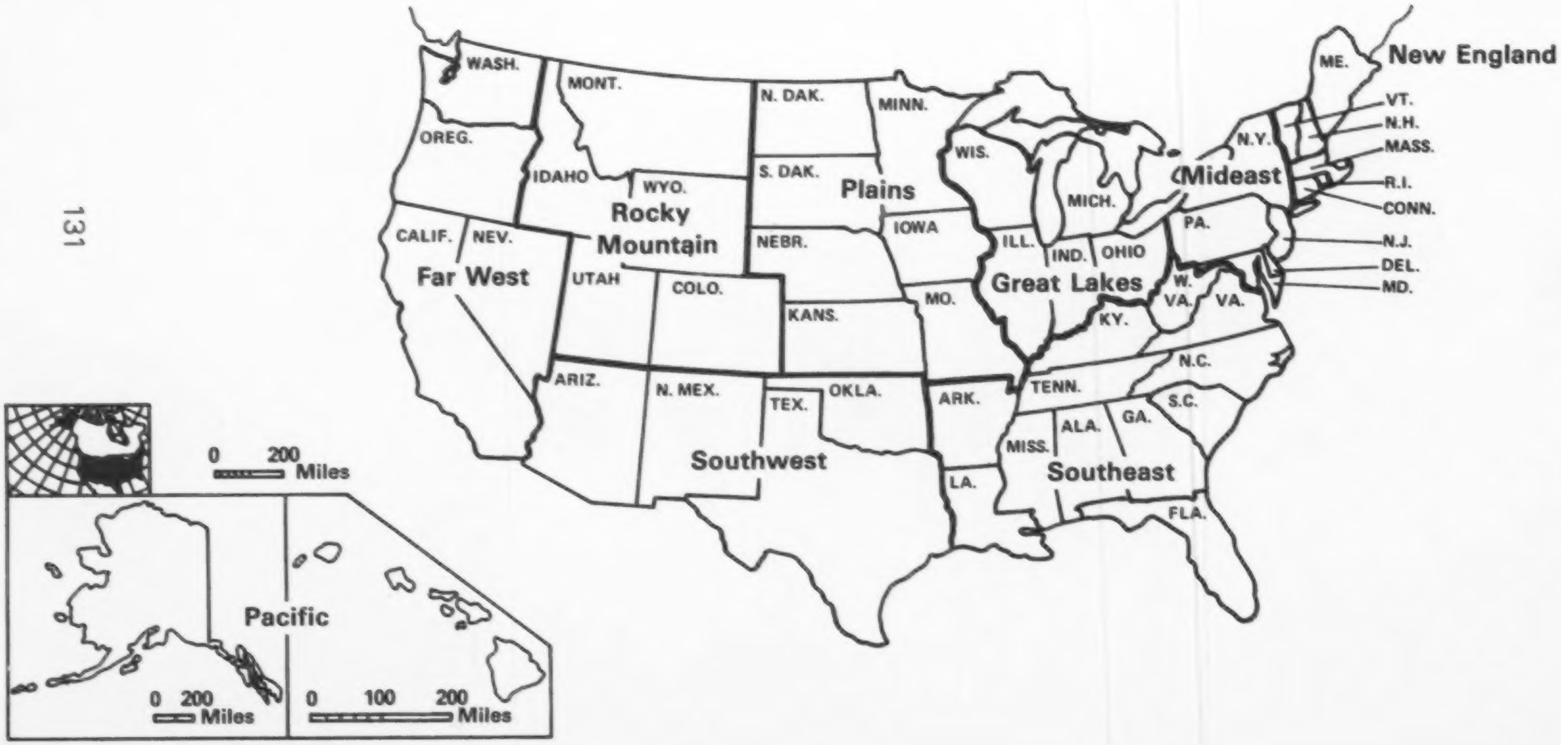

New England
ME.
VT.
N.H.
MASS.
R.I.
CONN.
N.J.
DEL.
MD.
N.Y.
Mideast
PA.
WASH.
MONT.
N. DAK.
MINN.
WIS.
MICH.
OREG.
IDAHO
WYO.
S. DAK.
Plains
Rocky
Mountain
CALIF.
NEV.
NEBR.
IOWA
ILL.
IND.
OHIO
Far West
UTAH
COLO.
Great Lakes
W. VA.
VA.
MO.
KANS.
KY.
N.C.
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
S.C.
ALA.
GA.
MISS.
Southwest
Southeast
LA.
FLA.
0 200 Miles
Pacific
0 200 Miles
0 100 200 Miles

Figure VI-2

U.S. Population Growth
1970-1980

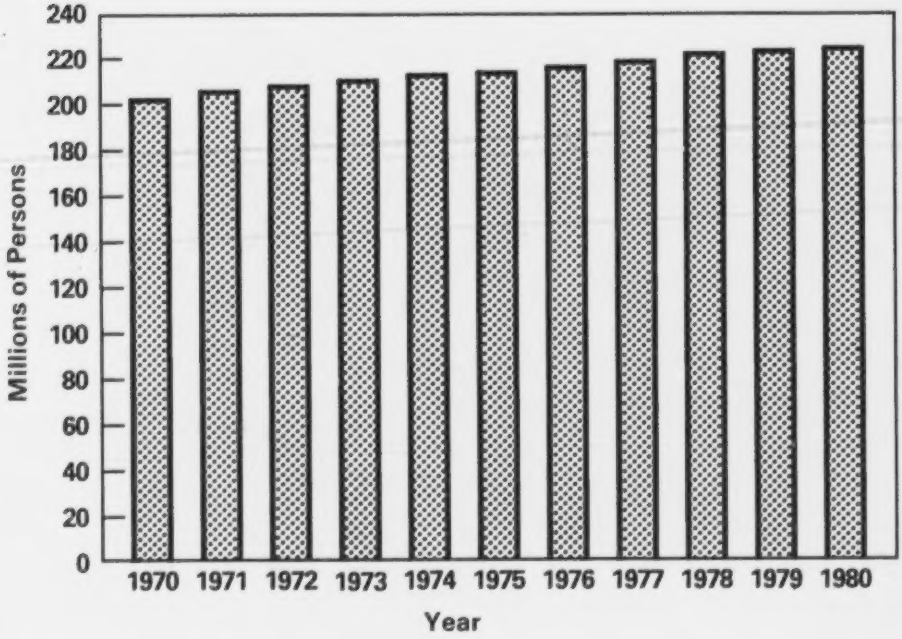


Figure VI-3

U.S. Population by Region 1970-2000

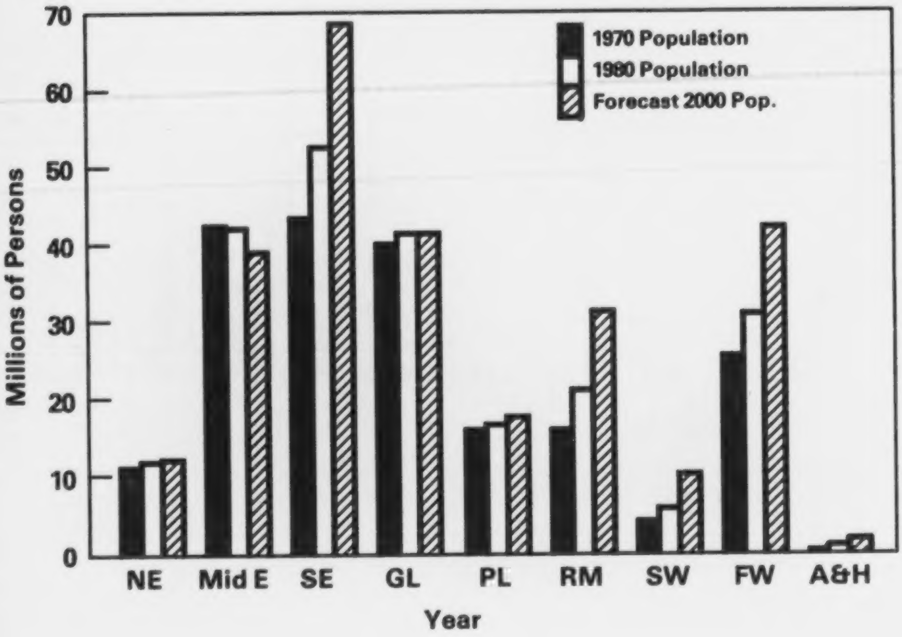


Figure VI-4

Urbanized Area Growth: 1970-1980
Total, Central City, Outside Central City

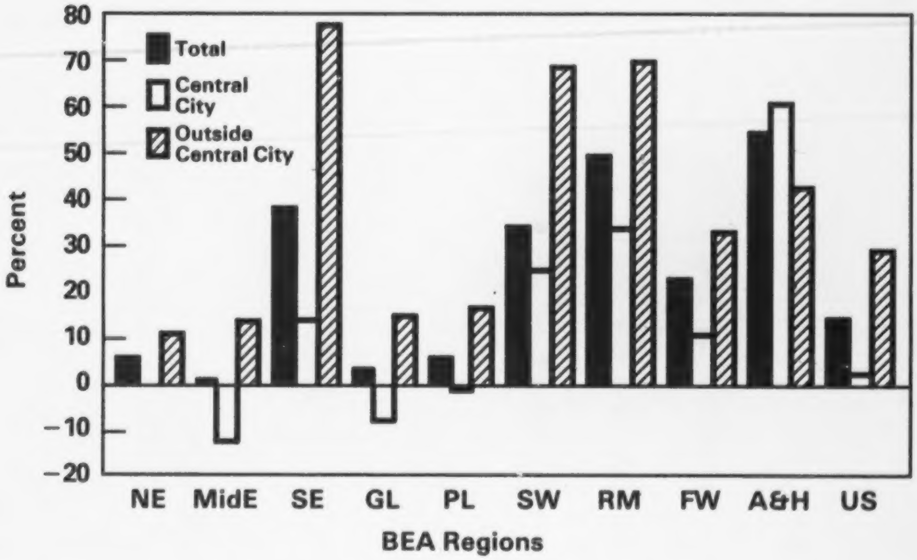


Figure VI-5

Urbanized Area Population: 1970-1980 Central City and Outside Central City

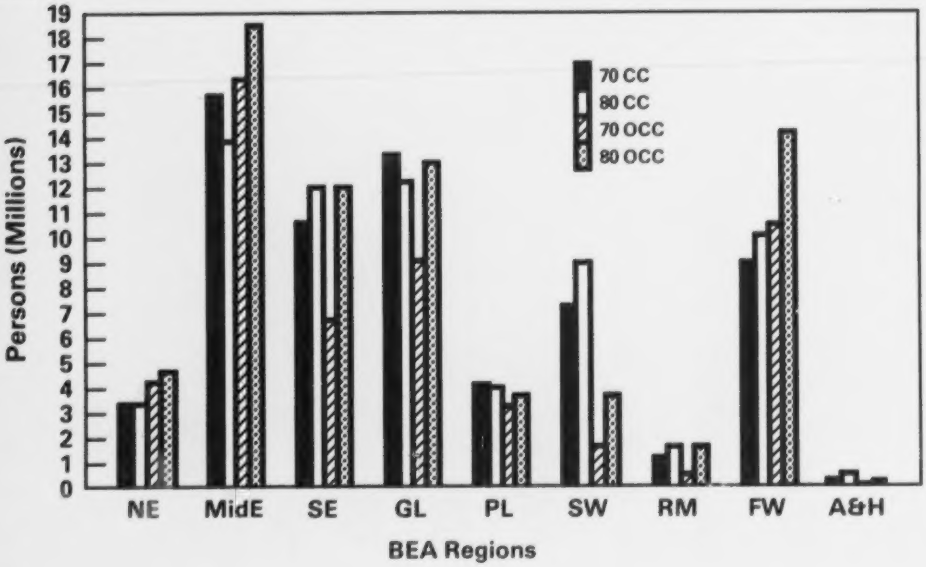


Figure VI-6

Urban Population

1980-2000

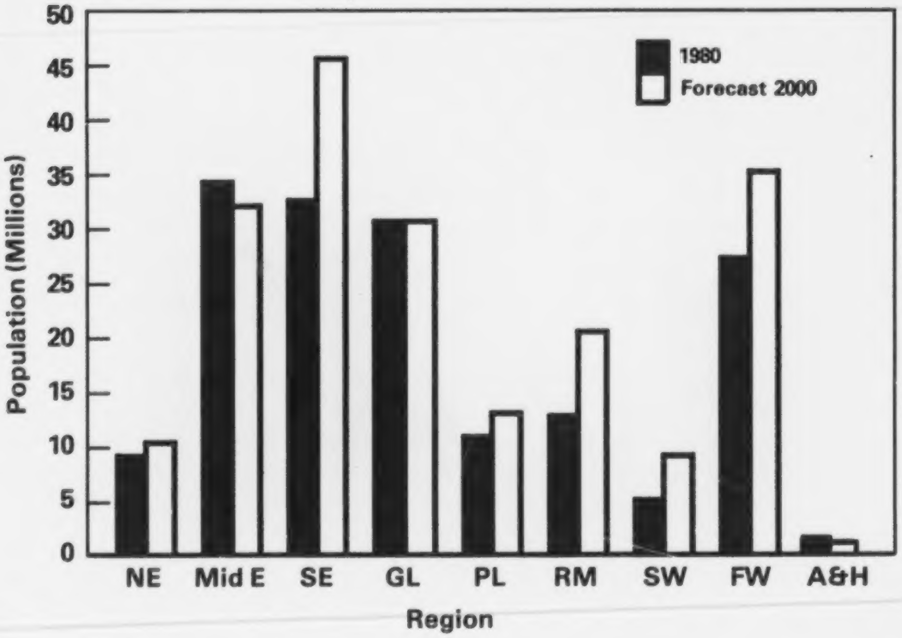


Figure VI-7

Rural Population
1980-2000

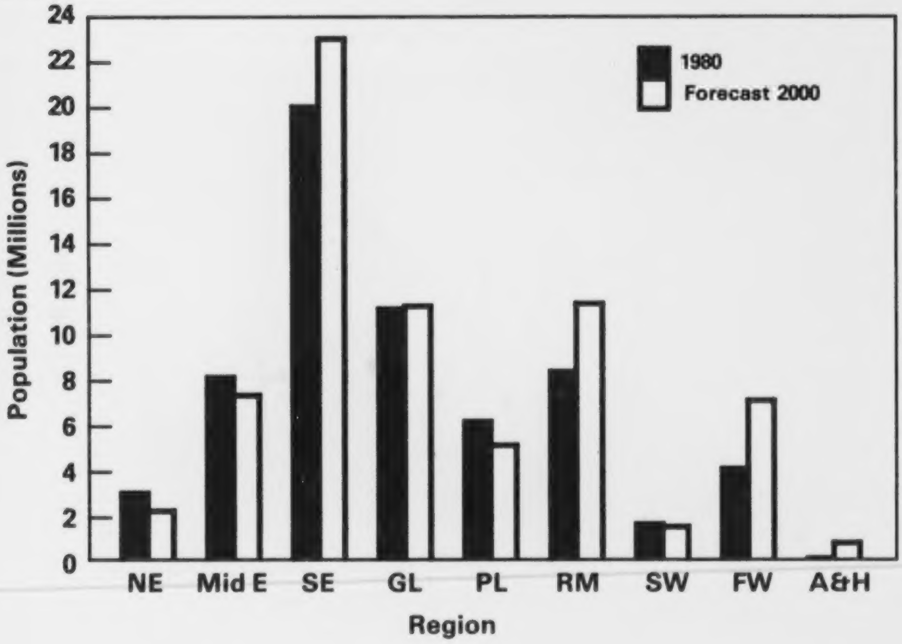


Figure VI-8

Daily VMT Per Capita

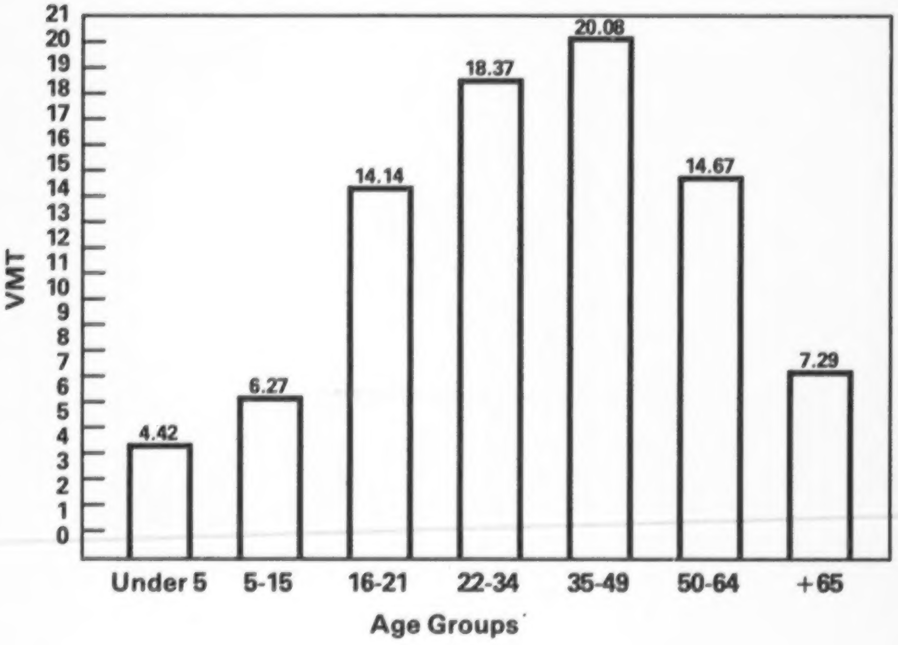


Figure VI-9

Age Distribution
1970-2000

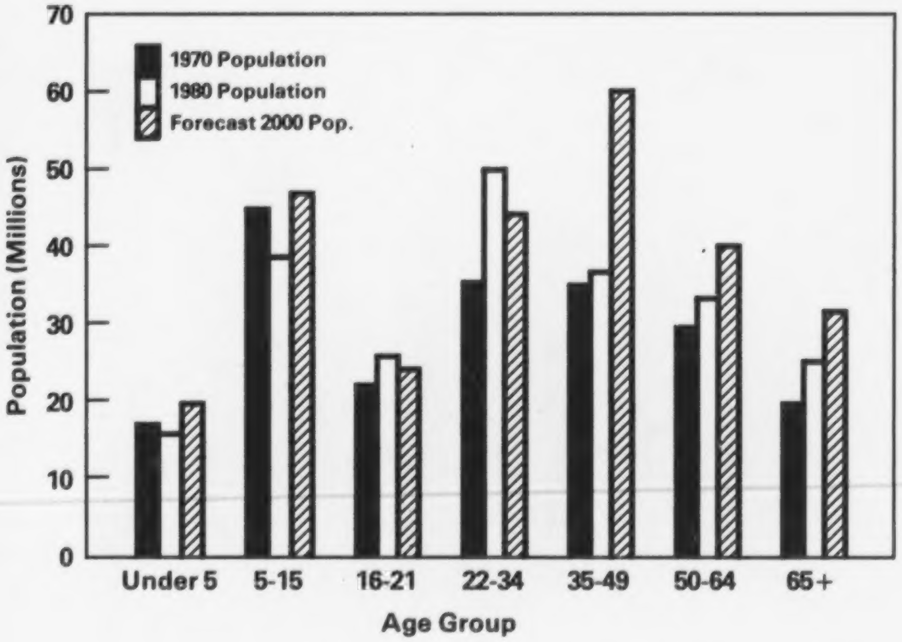


Figure VI-10

Weekday Trips by Household Size

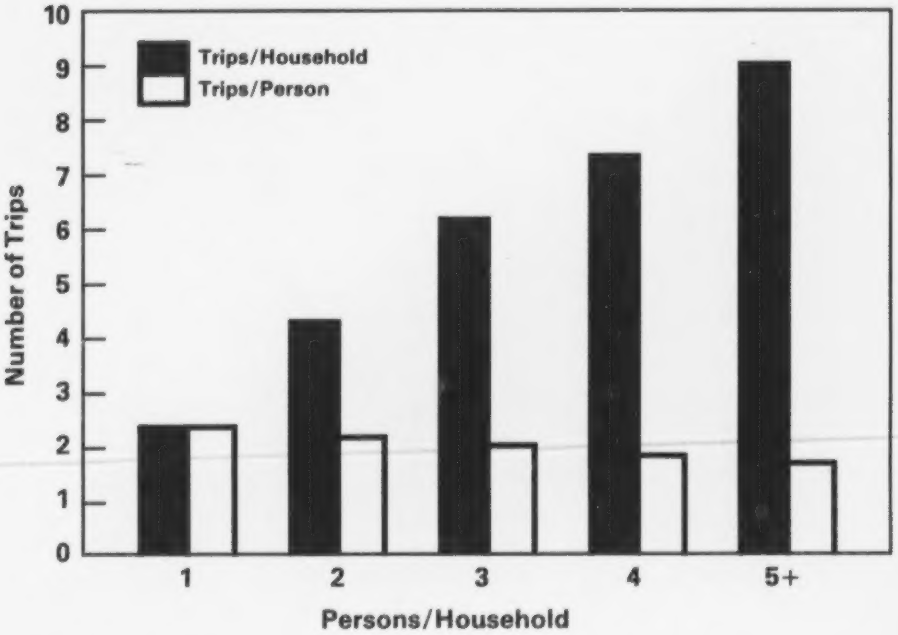


Figure VI-11

GNP and VMT as Indexes

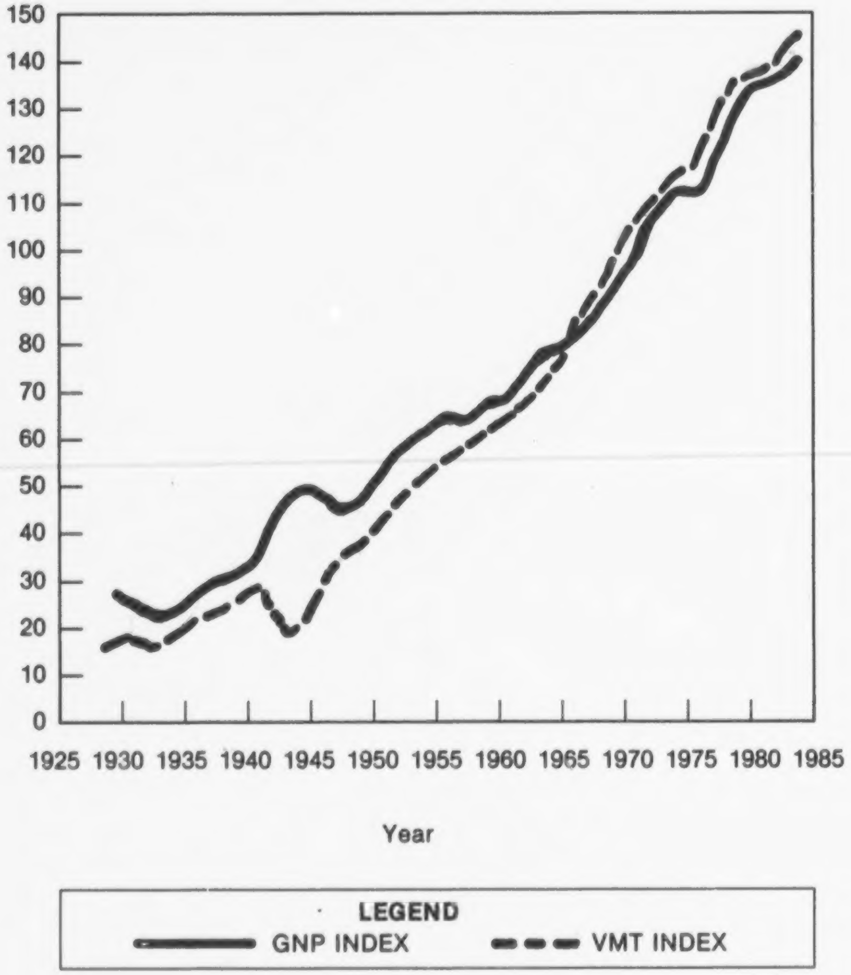


Figure VI-12

Employment by Industry 1970-2000

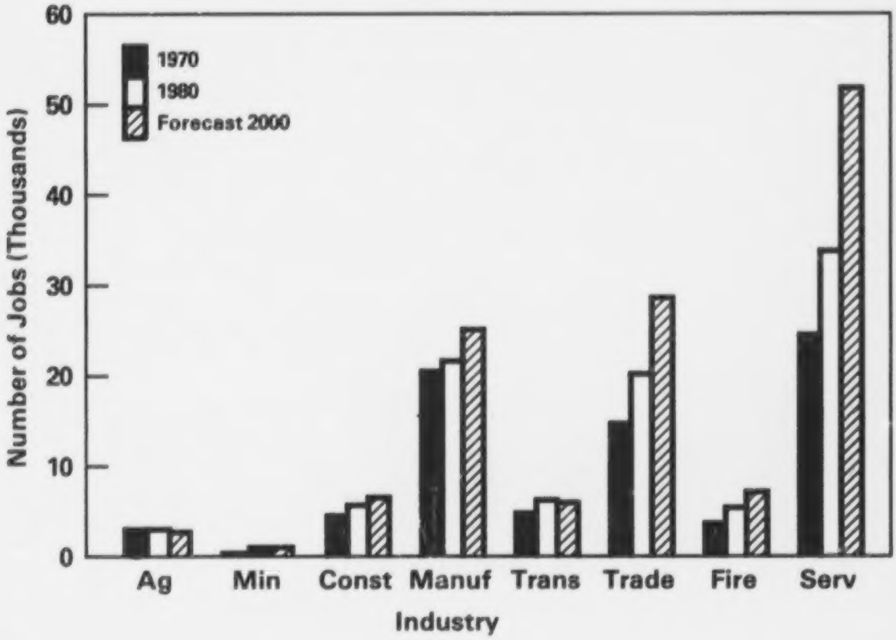


Figure VI-13

Average VMT by Household Income

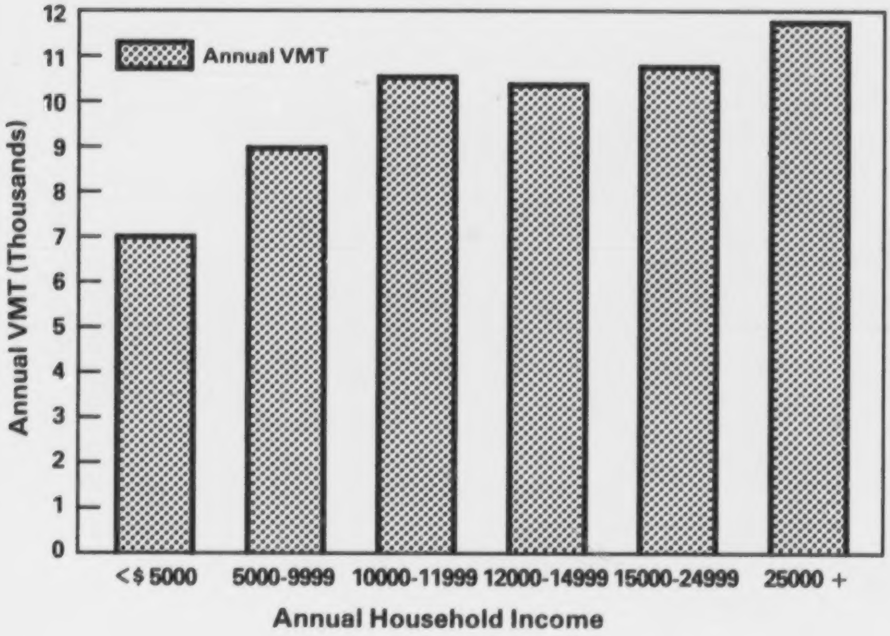


Figure VI-14

Disposable Personal Income/Capita
1970-1980

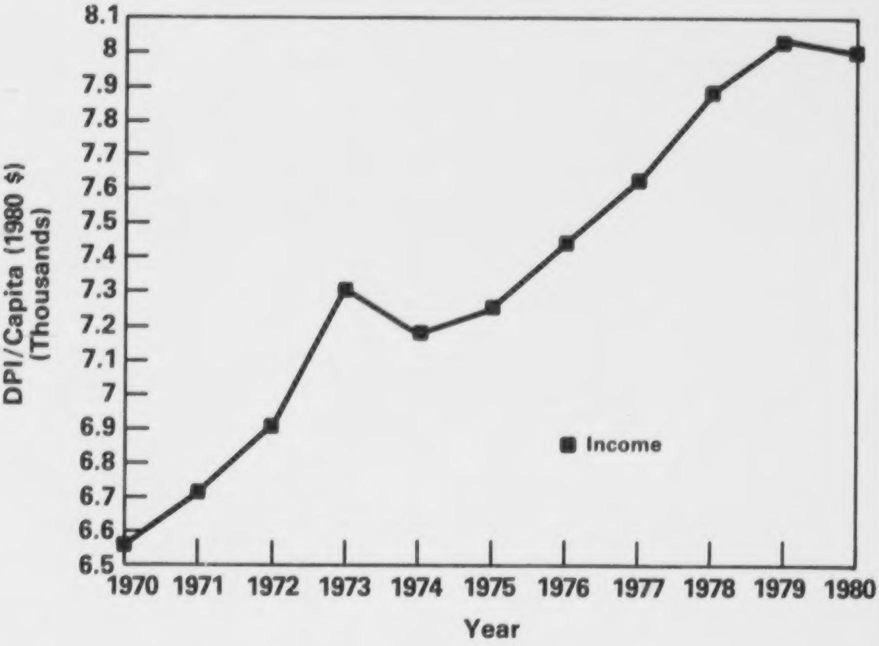


Figure VI-15

Disposable Personal Income/Capita
1970-2000

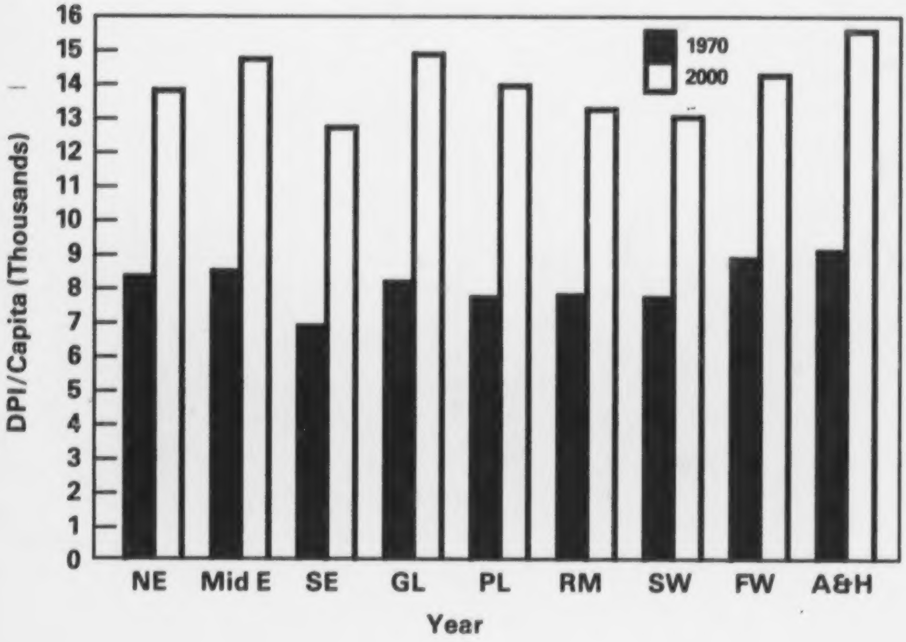


Figure VI-16

Labor & Proprietors Income 1970-2000

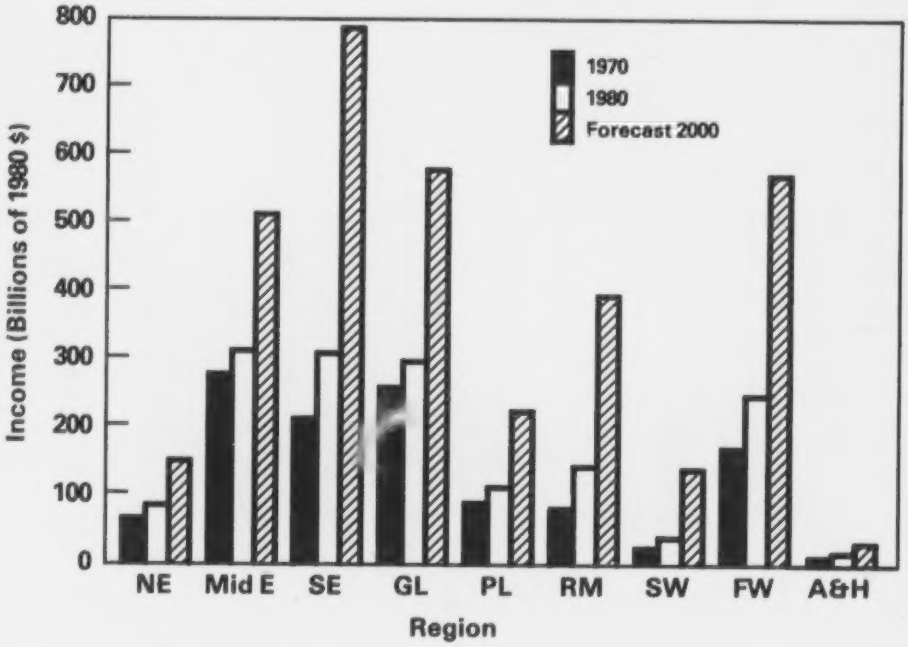


Figure VI-17

Auto Registration by Region
1970-1980

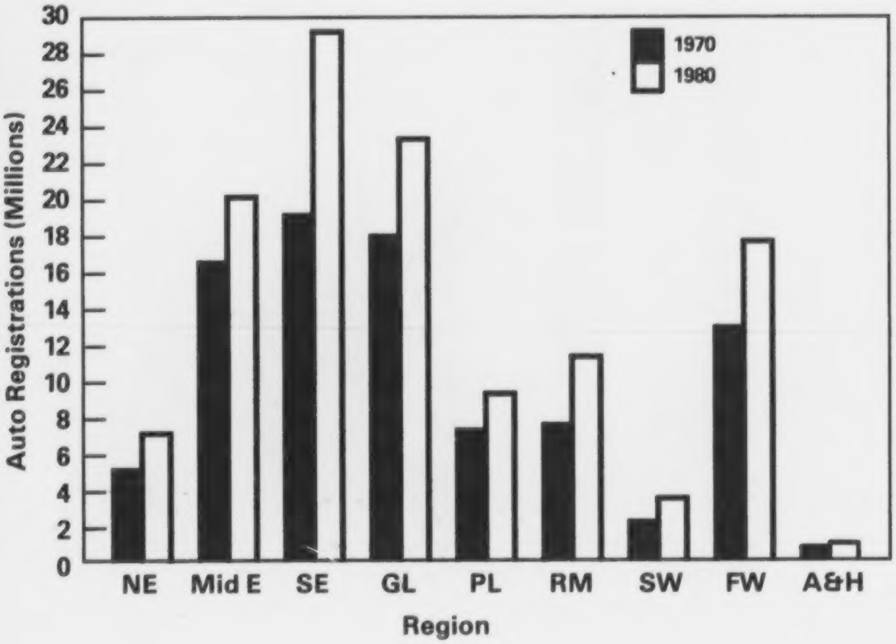


Figure VI-18

Passenger Cars by Age Group 1970-1980

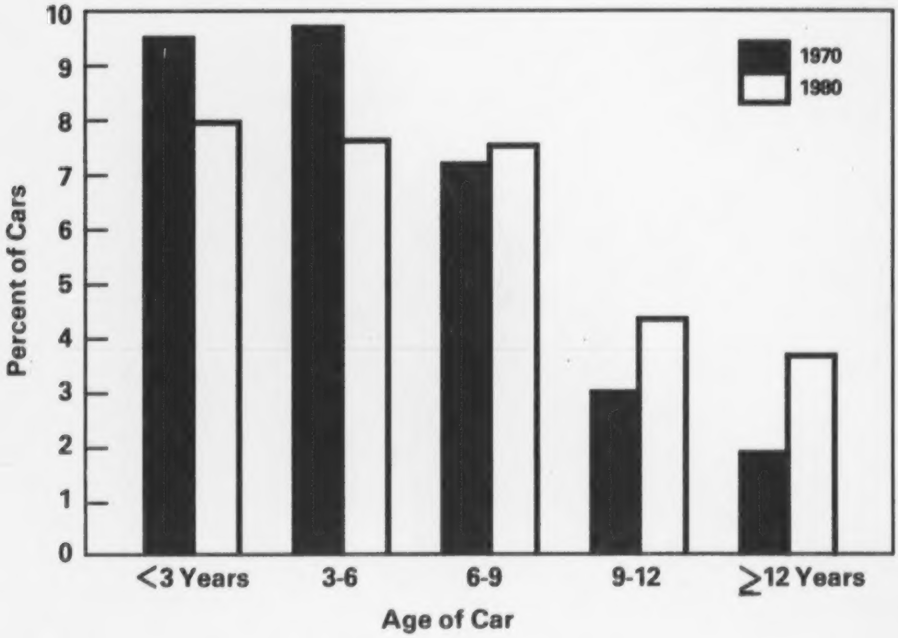


Figure VI-19

Highway Fatality Rates

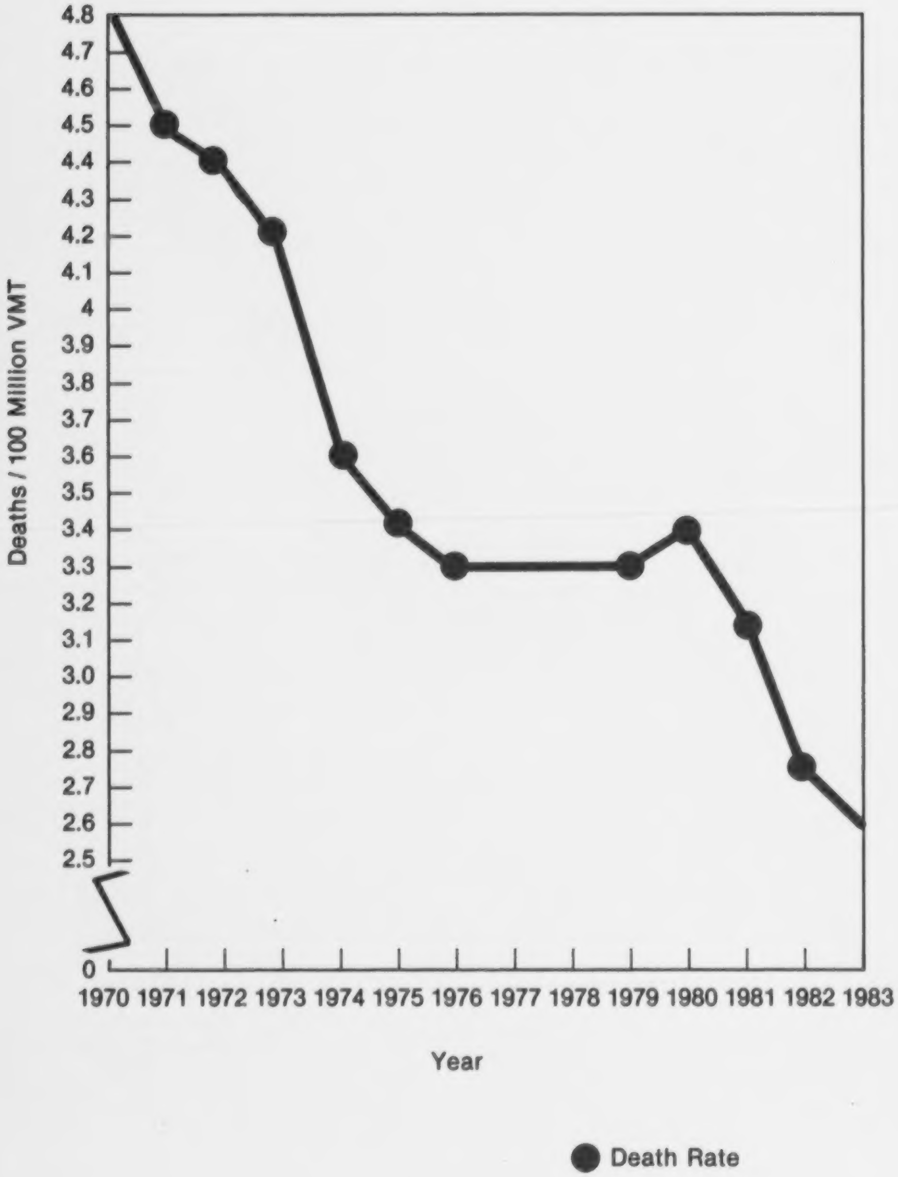


Figure VI-20

Mode of Travel
1970-1980

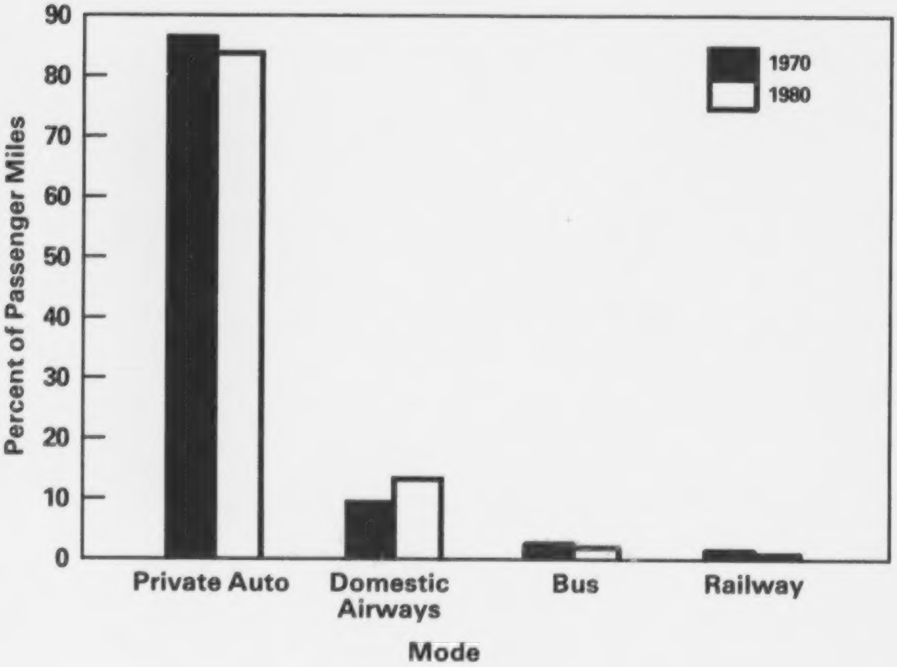


Figure VI-21

Freight Hauled by Mode
1970-1980

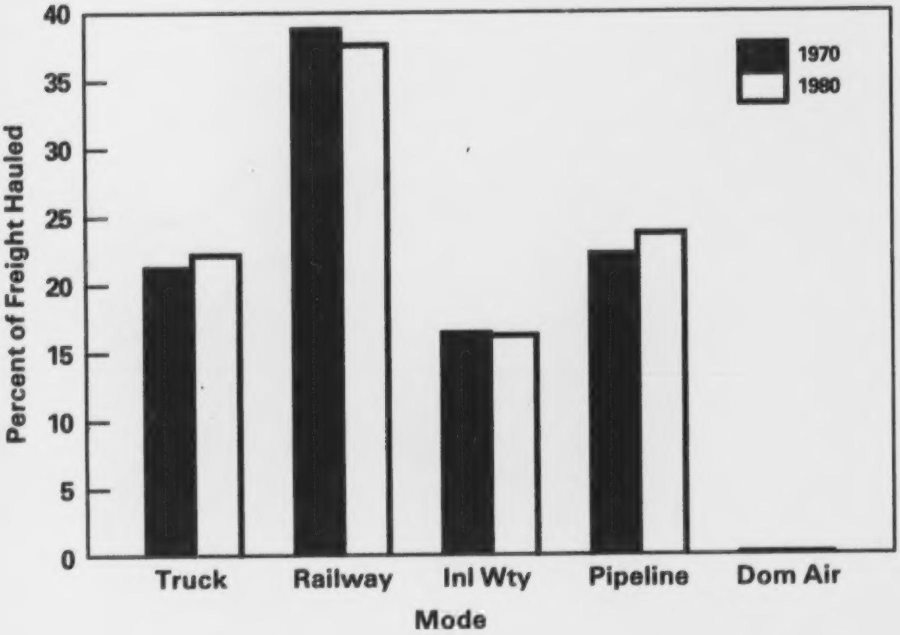


Figure VI-22

Public Transportation Use by State

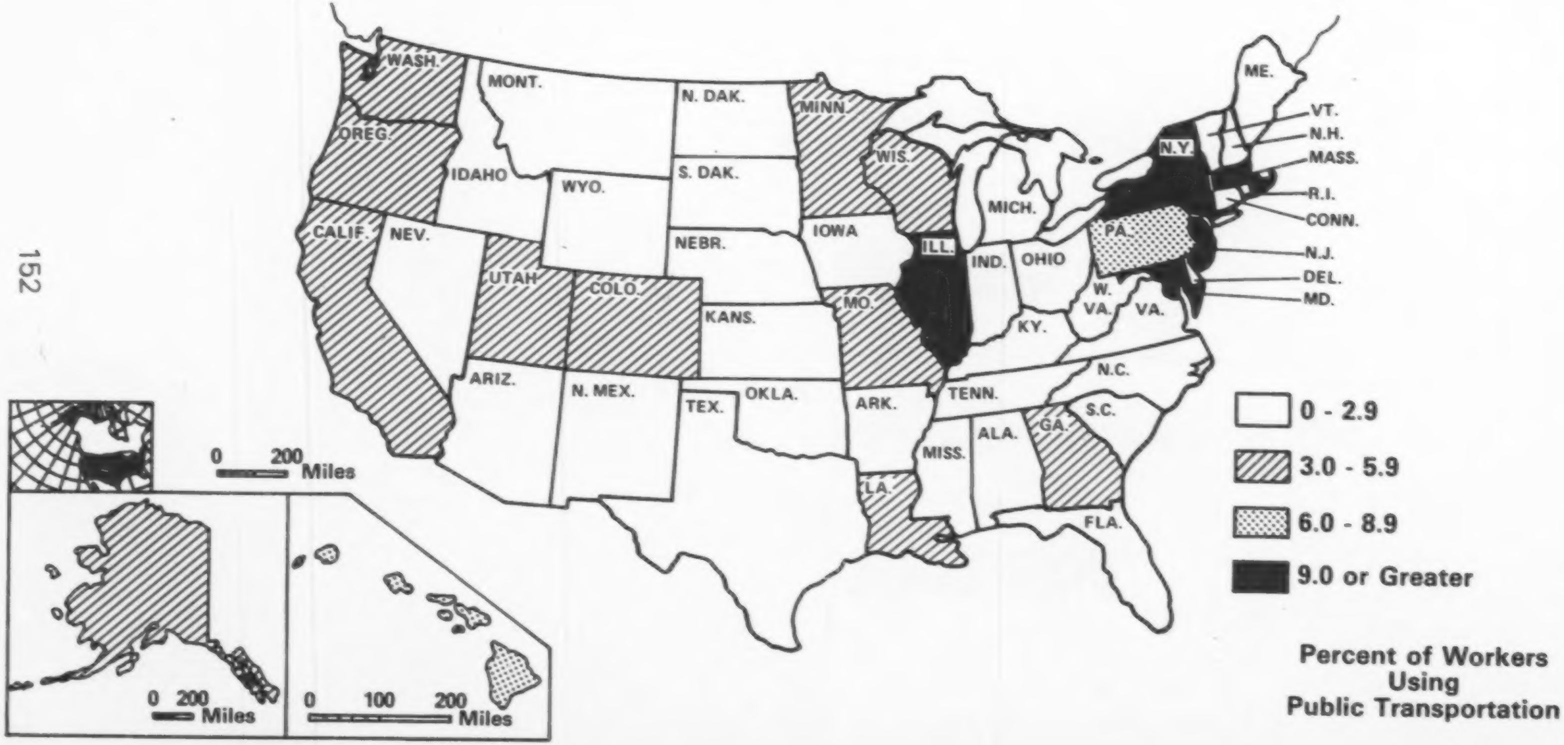
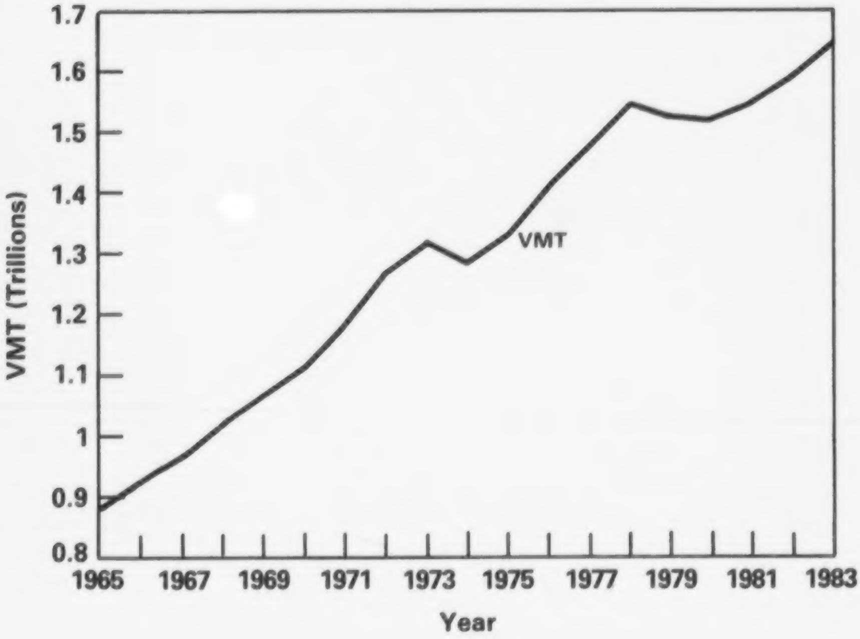

WASH.
MONT.
N. DAK.
MINN.
ME.
VT.
N.H.
MASS.
R.I.
CONN.
N.Y.
OREG.
IDAHO
WYO.
S. DAK.
WIS.
MICH.
CALIF.
NEV.
NEBR.
IOWA
ILL.
IND.
OHIO
PA.
N.J.
DEL.
MD.
UTAH
COLO.
KANS.
MO.
KY.
W. VA.
VA.
N.C.
ARIZ.
N. MEX.
TEX.
OKLA.
ARK.
TENN.
S.C.
MISS.
ALA.
GA.
LA.
FLA.
0 200 Miles
0 200 Miles
0 100 200 Miles
0 - 2.9
3.0 - 5.9
6.0 - 8.9
9.0 or Greater
Percent of Workers Using Public Transportation

Figure VI-23

Highway Travel
1965-1983



APPENDIX

Table A-1
Operating Costs for the Year 2000, Maintain Conditions Scenario

	Year 200 VMT (Millions)	Operating Costs (Millions)	Cost Per 1,000 VMT (Dollars)
Rural			
Interstate	248,715	$ 65,586.15	$263.70
Other Principal Arterials	219,111	55,960.95	255.40
Minor Arterials	212,013	49,929.06	235.50
Major Collectors	257,161	63,364.47	246.40
Minor Collectors	69,263	18,680.23	269.70
Urban			
Interstate	249,553	51,208.28	205.20
Other Freeways and Expressways	127,227	25,038.27	196.80
Other Principal Arterials	366,240	97,346.59	265.80
Minor Arterials	272,023	70,589.97	259.50
Collectors	116,835	30,166.80	258.20
Totals	2,138,141	$527,870.76	$246.88

Tables A-1 through A-9 demonstrate the procedures that were used to calculate the user costs associated with each highway condition scenario. The "Year 2000, Maintain Conditions" scenario is used for this particular example.

Table A-1 shows the projected operating cost per 1,000 VMT for the year 2000. These unit costs were produced directly by the HPMS analytical package. The table also shows the total annual operating costs (by functional class). The total cost figures were computed by multiplying the unit costs for each functinal class by the projected year 2000 VMT for that class.

Table A-2
Rates of Accidents per 100 Million VMT for the Year 2000, Maintain Conditions Scenario

	Year 2000 VMT (Millions	Total Accidents	Fatal Accidents	Nonfatal Injury Accidents
Rural				
Interstate	248,715	93	2.3	32
Other Principal Arterials	219,111	187	4.2	67
Minor Arterials	212,013	215	5.3	76
Major Collectors	257,161	215	5.8	75
Minor Collectors	69,263	212	6.3	73
Urban				
Interstate	249,553	239	1.2	82
Other Freeways and Expressways	127,227	275	1.6	91
Other Principal Arterials	366,240	585	2.5	181
Minor Arterials	272,023	597	2.8	183
Collectors	116,835	549	3.3	163
Total	2,138,141			

Tables A-2 through A-4 show the steps that were used in determining the accident component of the overall user costs. Table A-2 presents the rates of accidents per 100 million VMT by accident type. These rates were produced directly by the HPMS analytical package. Rates are included for total accidents, fatal accidents, and nonfatal injury accidents.

Table A-3
Numbers of Damaged Vehicles, Fatalities, and Nonfatal Injuries for the Year 2000, Maintain Conditions Scenario

	Damaged Vehicles	Fatalities	Nonfatal Injuries
Rural			
Interstate	393,218	6,453	181,995
Other Principal Arterials	696,554	10,381	334,239
Minor Arterials	774,908	12,675	368,083
Major Collectors	939,923	16,825	442,175
Minor Collectors	249,624	4,922	116,408
Urban			
Interstate	1,013,934	3,378	455,273
Other Freeways and Expressways	594,786	2,296	257,951
Other Principal Arterials	3,642,257	10,328	1,474,231
Minor Arterials	2,760,761	8,592	1,107,878
Collectors	1,090,421	4,349	424,852
Totals	12,156,386	80,198	5,163,086

The actual numbers of accidents were computed by multiplying the accident rates in Table A-2 by the respective VMT figures for each functional class. Factors to convert the numbers of accidents by type to the numbers of damaged vehicles, injured persons, and fatalities (Table A-3) were based on data taken from "The Economic Cost to Society of Motor Vehicle Accidents;" Table II, 1; National Highway Traffic Safety Administration. The factors were calculated as follows:

- The number of damaged vehicles per accident equals the total number of damaged vehicles divided by the total number of accidents.

  47,885,000 / 28,186,000 = 1.7

- The number of fatalities per fatal accident equals the total number of fatalities divided by the total number of fatal accidents.

  51,091 / 45,271 = 1.128

- The number of injured persons per nonfatal injury accident equals the sum of the number of injured persons for all five injury categories divided by the sum of the numbers of accidents for those categories.

  3,971,500 / 1,797,630 = 2.209

- The number of injured persons per fatal accident (in addition to the fatalities) was assumed to equal the rate of injured persons per nonfatal accident minus the number of fatalities per fatal accident. This calculation assumes that the average number of dead and injured persons per fatal accident equals the average number of injured persons per nonfatal injury accident.

  2.209 - 1.128 = 1.081

Table A-4
Economic Costs of Accidents by Component for the Year 2000, Maintain Conditions Scenario

	Vehicle Costs (Millions)	Fatality Costs (Millions)	Injury Costs (Millions)	Total Costs (Millions)	Cost Per 1,000 VMT (Dollars)
Rural					
Interstate	$ 185.21	$ 1,734.00	$ 701.41	$ 2,620.62	$10.54
Other Principal Arterials	328.08	2,789.55	1,288.16	4,405.78	20.11
Minor Arterials	364.98	3,406.11	1,418.59	5,189.68	24.48
Major Collectors	442.70	4,521.20	1,704.14	6,668.04	25.93
Minor Collectors	117.57	1,322.70	448.64	1,888.91	27.27
Urban					
Interstate	477.56	907.75	1,754.62	3,139.93	12.58
Other Freeways and Expressways	280.14	617.05	994.14	1,891.34	14.87
Other Principal Arterials	1,715.50	2,775.40	5,681.69	10,172.59	27.78
Minor Arterials	1,300.32	2,308.79	4,269.76	7,878.87	28.96
Collectors	513.59	1,168.71	1,637.38	3,319.68	28.41
Totals	$5,725.66	$21,551.26	$19,898.53	$47,175.45	$22.06

Table A-4 presents the economic costs of the damaged vehicles, fatalities, and injuries that were calculated in Table A-3. The per unit economic costs of these events were also taken from the National Highway Traffic Safety Administration report cited above. The unit costs of property damage and fatalities were taken directly as reported. For injuries, an average (weighted by incidence) of the costs by injury type was used. These calculations resulted in the following economic cost rates.

- $471 per damaged vehicle
- $3,854 per nonfatal injury
- $268,727 per fatality

Table A-4 also presents the total accident-based costs (the sum of vehicle, fatality, and injury costs) and finally the unit costs per 1,000 VMT.

Table A-5
Average Travel Speeds (m.p.h.) for the Year 2000, Maintain Conditions Scenario

	Light Auto	Heavy Auto	Pickup and Van	Unit 2 Axle	Unit 3 + Axle	Multi 4 Axle	Multi 5 + Axle
Rural							
Interstate	55.1	55.1	53.4	52.4	49.8	39.4	38.3
Other Principal Arterials	44.4	44.5	43.7	41.1	39.8	32.1	31.5
Minor Arterials	39.9	40.0	39.6	37.2	35.9	29.7	29.2
Major Collectors	35.5	35.5	35.4	32.4	32.7	27.9	27.0
Minor Collectors	30.5	30.4	30.6	24.8	28.9	24.8	22.5
Urban							
Interstate	42.3	42.3	41.6	43.0	41.1	34.6	33.8
Other Freeways and Expressways	40.8	40.8	40.3	40.2	38.7	32.4	31.8
Other Principal Arterials	18.3	18.3	19.0	17.7	17.6	14.2	14.1
Minor Arterials	18.2	18.1	18.9	17.5	17.3	14.0	13.9
Collectors	18.0	18.0	18.8	17.1	16.8	13.7	13.5

Tables A-5 through A-8 show the calculation steps that were used to calculate the travel time component of the overall user costs. The HPMS analtyical package does not directly calculate either the time spent in travel or the costs of that time, but instead projects average travel speeds. Speeds are calculated for each vehicle type on each functional class. The average travel speed data are presented in Table A-5.

Table A-6
Percent of VMT on Each Functional Class by Vehicle Type for the Year 2000, Maintain Conditions Scenario

	Light Auto	Heavy Auto	Pickup and Van	Unit 2 Axle	Unit 3 + Axle	Multi 4 Axle	Multi 5 + Axle
Rural							
Interstate	18.6	42.3	17.9	2.5	0.9	1.8	15.9
Other Principal Arterials	15.5	46.1	24.8	3.1	1.2	1.7	7.7
Minor Arterials	18.5	42.4	28.1	3.2	1.8	1.0	4.9
Major Collectors	14.0	44.5	32.6	2.6	1.6	1.2	3.5
Minor Collectors	14.1	44.9	32.9	2.3	1.5	1.1	3.2
Urban							
Interstate	22.6	50.0	17.0	2.0	0.9	1.0	6.7
Other Freeways and Expressways	23.3	51.5	17.5	1.5	0.6	0.7	4.9
Other Principal Arterials	19.4	54.8	19.1	2.4	0.8	0.7	2.8
Minor Arterials	18.6	56.4	19.1	2.4	1.2	0.4	1.9
Collectors	19.6	53.0	22.8	2.0	0.9	0.6	1.1

In order to compute the travel time costs resulting from the speeds in Table A-5, it was first necessary to determine the VMT for each group. Table A-6 shows the relative percentage mix of VMT on each functional class that is predicted to exist for each vehicle type. These percentages are produced directly by the HPMS analytical package.

Table A-7
Millions of Hours of Annual Travel Time for the Year 2000, Maintain Conditions Scenario

	Light Auto	Heavy Auto	Pickup and Van	Unit 2 Axle	Unit 3 + Axle	Multi 4 Axle	Multi 5 + Axle	Totals
Rural								
Interstate	839.582	1,909.373	833.708	118.662	44.948	113.626	1,032.524	4,892.424
Other Principal Arterials	764.915	2,269.891	1,243.467	165.266	66.064	116.040	535.605	5,161.248
Minor Arterials	983.018	2,247.338	1,504.436	182.377	106.302	71.385	355.775	5,450.630
Major Collectors	1,014.156	3,223.567	2,368.206	206.364	125.828	110.607	333.357	7,382.085
Minor Collectors	320.199	1,022.996	744.690	64.236	35.950	30.721	98.507	2,317.301
Urban								
Interstate	1,333.309	2,949.799	1,019.808	116.071	54.647	72.125	494.676	6,040.435
Other Freeways and Expressways	726.566	1,605.929	552.475	47.473	19.725	27.487	196.042	3,175.696
Other Principal Arterials	3,882.544	10,967.187	3,681.676	496.597	166.473	180.541	727.285	20,102.302
Minor Arterials	2,780.015	8,476.297	2,749.016	373.060	188.686	77.721	371.830	15,016.625
Collectors	1,272.203	3,440.142	1,416.935	136.649	62.590	51.169	95.199	6,474.887
Totals	13,916.508	38,112.519	16,114.416	1,906.754	871.213	851.422	4,240.800	76,013.633

Table A-7 shows the millions of hours of travel time by functional class and vehicle type. These figures were calculated by multiplying the vehicle-type percentages of VMT in Table A-6 by the VMT's per functional class in Table A-1. The computed VMT's by functional class and vehicle type were then divided by the corresponding average travel speeds in Table A-5 to determine the hours of annual travel time.

Table A-8
Annual Cost of Travel for the Year 2000, Maintain Conditions Scenario
(In millions of Dollars)

	Light Auto	Heavy Auto	Pickup and Van	Unit 2 Axle	Unit 3 + Axle	Multi 4 Axle	Multi 5 + Axle	Total Costs	Cost Per 1,000 VMT
Unit Costs Per Hour:	$ 5.56	$ 5.56	$ 6.78	$ 7.51	$ 10.00	$ 11.00	$ 11.00		
Annual Costs: Rural									
Interstate	$ 4,668.08	$ 10,616.11	$ 5,652.51	$ 891.15	$ 449.48	$11,249.89	$11,357.77	$ 34,885.02	$140.26
Other Principal Arterials	4,252.92	12,620.60	8,430.71	1,241.15	660.64	1,276.44	5,891.65	34,374.11	156.88
Minor Arterials	5,465.58	12,495.20	10,200.07	1,369.65	1,063.02	785.23	3,913.53	35,292.28	166.46
Major Collectors	5,638.71	17,923.04	16,056.44	1,549.79	1,258.28	1,216.68	3,666.93	47,309.85	183.97
Minor Collectors	1,780.31	5,687.86	5,049.00	482.41	359.50	337.94	1,083.58	14,780.59	213.40
Annual Costs: Urban									
Interstate	7,413.20	16,400.88	6,914.30	871.69	546.47	793.38	5,441.44	38,381.35	153.80
Other Freeways and Expressways	4,039.71	8,928.97	3,745.78	356.52	197.25	302.36	2,156.46	19,727.04	155.05
Other Principal Arterials	21,586.95	60,977.56	24,961.76	3,729.44	1,664.73	1,985.95	8,000.14	122,906.52	335.59
Minor Arterials	15,456.88	47,128.21	18,638.33	2,801.68	1,886.86	854.93	4,090.13	90,857.03	334.00
Collectors	7,073.45	19,127.19	9,606.82	1,026.23	625.90	562.85	1,047.19	39,069.64	334.40
Total	$77,375.78	$211,905.61	$109,255.74	$14,319.72	$8,712.13	$9,365.64	$46,648.80	$477,583.43	$223.36

Table A-8 shows the unit costs of travel time per hour and the calculated annual costs of travel time. The unit costs were taken from "Time Values per Vehicle Hour for Seven Vehicle Classes;" EXP Associates, Inc.; March 1983; produced under contract to the FHWA. The annual costs attributed to travel time were calculated by multiplying the unit costs above times the hours of annual travel time in Table A-7.

Table A-9
Summary of Combined Costs and Unit Costs for the Year 2000, Maintain Conditions Scenario

	COSTS (MILLIONS)				COSTS PER 1,000 VMT			
	Operating Costs	Accident Costs	Time Costs	Total Costs	Operating Unit Costs	Accident Unit Costs	Time Unit Costs	Total Unit Costs
Rural								
Interstate	$ 65,586.15	$ 2,620.62	$ 34,885.02	$ 103,091.79	$263.70	$10.54	$140.26	$414.50
Other Principal Arterials	55,960.95	4,405.78	34,374.11	94,740.84	255.40	20.11	156.88	432.39
Minor Arterials	49,929.06	5,189.68	35,292.28	90,411.02	235.50	24.48	166.46	426.44
Major Collectors	63,364.47	6,668.04	47,309.85	117,342.37	246.40	25.93	183.97	456.30
Minor Collectors	18,680.23	1,888.91	14,780.59	35,349.74	269.70	27.27	213.40	510.37
Urban								
Interstate	51,208.28	3,139.93	38,381.35	92,729.56	205.20	12.58	153.80	371.58
Other Freeways and Expressways	25,038.27	1,891.34	19,727.04	46,656.65	196.80	14.87	155.05	366.72
Other Principal Arterials	97,346.59	10,172.59	122,906.52	230,425.71	265.80	27.78	335.59	629.17
Minor Arterials	70,589.97	7,878.87	90,857.03	169,325.86	259.50	28.96	334.00	622.47
Collectors	30,166.80	3,319.68	39,069.64	72,556.11	258.20	28.41	334.40	621.01
Totals	$527,870.76	$47,175.45	$477,583.43	$1,052,629.65	$246.88	$22.06	$223.36	$492.31

Table A-9 summarizes the results of the previous tables and calculations and shows the operating, accident, and travel time components of the combined user costs resulting from the projected year 2000 highway conditions. Both the total annual costs and the unit costs per 1,000 VMT are shown.